Institute for Empirical Research in Economics
University of Zurich

Working Paper Series
ISSN 1424-0459

Working Paper No. 382

Suburbanization and Homeownership Rates

Wolfgang R. Köhler

July 2008

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Wolfgang R. Köhler

University of Zürich

Institut für empirische Wirtschaftsforschung

Winterthurerstrasse 30

8006 Zürich, Switzerland

Phone: 0041-44-6343588

wolfgang.koehler@iew.uzh.ch

July 31, 2008

*I would like to thank Gregory Besharov, Chris Laincz, Thomas Nechyba, Curtis Taylor, Huseyin Yildirim, and Jacob Vigdor.

Abstract

Homeownership rates in suburbs are much higher than in central cities. This paper shows that the systematic difference between homeownership rates causes suburbanization. We consider an economy with several regions: the central city, where most households rent, and the suburbs, where most own. Households migrate and vote on local policies. Renters do not consider the effect of policies on house prices. Therefore, renter dominated central cities provide public goods inefficiently and have high taxes and high debt. Since house prices are lower in the central city, few houses are built and households migrate to the suburbs as houses depreciate. The durability of houses has two effects: it provides owners with incentives to vote for efficient policies and it makes inefficient policies sustainable.

JEL Codes: H41, H73

Keywords: Suburbanization; Homeownership; Migration; Local Public Debt; Local Public Goods; House Prices

1. Introduction

Suburbanization has been the dominant feature in the development of large cities in the United States in the last 50 years. While the population growth in metropolitan statistical areas (MSAs) was higher than the U.S. average, many central cities experienced a declining population as most of the growth occurred in the suburbs. Gyourko and Voith (1997) find that the population of 17 of the 20 largest U.S. cities that have had no change in land area declined between 1960-1990 and that the share of the metropolitan population that lives in the central city declined in all 20 cities. Baum-Snow (2005) uses boundaries of central cities in 1950 to compute constant area population figures. He shows that the aggregate population of constant area central cities declined by 17% between 1950 and 1990. During this time, the population of the U.S. increased by 64%. In the 1990s, suburbanization continued as suburbs grew rapidly although most central cities experienced small populations gains. Suburbanization is even more striking if seen against the background of population densities. The average population density of U.S. central cities with more than 250,000 inhabitants in 1990 was 5322 inhabitants per square mile.[1] Compared to other western countries, central cities in the U.S. are not densely populated so that suburbanization is not the inevitable result of an increasing demand for larger homes.

Most attempts to explain suburbanization concentrate on attributes of central cities and suburbs (location of jobs, access to highways, ethnic and social diversity, etc.) or on attributes of households (preferences and income) that make some households more likely to migrate to the suburbs than others. This paper shows that there exists another fundamental reason for suburbanization. Suburbanization and the decline of central cities are the result of differences in the local policies of central cities and suburbs. Local policies differ because the percentage of homeowners is much higher in suburbs. In 2/2008, the average homeownership rate in central cities of MSAs was 53.4%. For suburbs, the average homeownership rate was 75.5%.[2]

We develop a political economy theory of suburbanization. To analyze the effect of different homeown-

[1]Source: 1990 Census of Population and Housing. Density is computed as population divided by urbanized area.
[2]Source: U.S. Census Bureau, Housing Vacancies and Homeownership. Both rates increased by about 5% during the last decade, with the rate of homeownership for suburbs being close to the rate for communities outside MSAs.

ership rates, we develop an infinite horizon model of an economy that consists of several regions, where regions correspond to local jurisdictions (i.e., cities). Ex ante, regions differ only with respect to their majorities. Initially, in one region (the central city) the majority of households rent while in the other regions (the suburbs) the majority of households are homeowners.[3] Households have identical preferences and can migrate at zero cost. Households vote on the policy of the region in which they live. Policies specify taxes and levels of public good provision. We distinguish between two classes of public goods. Durable public goods depreciate over time whereas non-durable public goods can only be consumed in the period in which they are provided. Regions finance public goods via taxes and debt. Contrary to renters, owners take the effect of the policy on the price of their house into consideration when they vote. Therefore, the region with a renter majority provides an inefficiently low level of the durable public good while regions with an owner majority provide the efficient level. Conditional on the level of the durable public good, taxes and public debt are higher in the renter dominated region.

The model shows that the different objectives of renters and owners explain why the policies of renter dominated central cities and owner dominated suburbs differ, specifically why the quality of public services is lower in central cities and why taxes and public debt are high compared to taxes and debt of suburbs. The difference between the policies causes migration to the suburbs. High taxes and a low level of public goods are the reason that rents in renter dominated central cities are so low that house prices are below construction costs. Therefore, no houses are built and as houses depreciate, households migrate to the owner dominated suburbs. This relation between house prices, depreciation, and migration has been documented by Glaeser and Gyourko (2005). They show that the population declines when house prices are below construction costs. Gyourko and Saiz (2003) show that house prices - relative to construction costs - are lower in central cities.

Similar to Glaeser and Gyourko (2005), the model highlights the importance of the durability of houses. We show that durability has two effects. Since houses are durable, homeowners have an incentive to vote

[3] The fact that owner occupied homes dominate in suburbs is no accident. One of the reasons are the strings that were attached to federal subsidies which heavily favoured suburbs and new developments over inner cities, because inner cities were perceived as declining (see Jackson (1985) for a detailed account of the history of suburbanization and the effect of federal subsidies). For the argument of this paper, the historic reasons for the distribution of renters and owners do not matter.

for the efficient policy. This contrasts sharply with the second effect. We show that the durability of houses makes inefficient policies sustainable although there are no migration costs.

Associated with suburbanization is the decline of central cities. The term 'decline' is usually used to summarize different features, ranging from high crime, high poverty rates, and racial issues to the low quality of public services, the critical financial situation and the falling population of many central cities. Mills and Lubuele (1997) review and discuss studies that analyze the economic and social issues of central cities in the United States. Mieszkowski and Mills (1993) provide a summary of theories that have been offered to explain suburbanization. They distinguish between two classes of theories: 'natural evolution' theories and 'flight from blight' theories. 'Natural evolution' theories are based on the monocentric city model. Employment is concentrated at a central location and land rents adjust to compensate for transportation costs. These theories emphasize the effects of transportation costs and rising incomes. Contrary to the predictions of monocentric models, house prices are not higher in the central city (Gyourko and Saiz, 2003, Mills and Simenauer, 1996). Additionally, in most MSAs, jobs are only slightly more concentrated than residences (Glaeser and Kahn, 2003). 'Natural evolution' theories do not consider inter-jurisdiction migration or the role of local policies. But MSAs usually cover many local jurisdictions and households that leave the central city frequently stay in the MSA but migrate to a suburb that is located in a different jurisdiction. Inter-jurisdiction migration and the role of local policies are at the center of 'flight from blight' theories. These theories stress the fiscal and social problems and the low level of public services in central cities. Depending on income and preferences, households migrate to the suburbs to avoid problems such as crime, high taxes, and the poor quality of public schools and services. When migrating to the suburbs, households sort themselves along the lines of income or preferences. A number of papers estimate the effect of parameters like crime and poverty rates on the migration decisions.[4]

Formalizations of the 'flight from blight' hypothesis are based on Tiebout models. The relevance of the Tiebout model for the analysis of suburbanization depends on whether Tiebout sorting is indeed the main force that drives migration. To address this question, Rhode and Strumpf (2003) introduce migration costs in a Tiebout model. Their model predicts that the heterogeneity across communities (in terms of

[4] For example, South and Crowder (1997), Cullen and Levitt (1999), Bayoh et al. (2006), Hoyt and Rosenthal (1997).

preferences, incomes, and public good provision) increases as migration costs fall. They analyze a sample of U.S. municipalities and counties from 1850-1990 and show that, contrary to the predictions of the Tiebout Model, the heterogeneity decreased although migration costs fell significantly.

Hoff and Sen (2005) combine the stratification idea of Tiebout models with the notion that homeownership matters. They develop a static model to show that individuals with different incomes can self-organize into neighborhoods with different civic environments. If house prices depend on civic efforts, then homeowners have a larger incentive to exert civic effort. If credit markets are imperfect, homeownership is beyond the reach of the poor. Together with the assumption that the marginal return to civic effort increases in the effort of other households, this leads to neighborhoods that are segregated by income and homeownership rates.

We are interested in the migration from central cities to suburbs. We do not discuss migration between MSAs or why some MSAs grow faster than others. Since the population density in central cities is usually higher than in suburbs, suburbanization is associated with sprawl. We do not analyze sprawl and its potential costs and benefits. Most of the costs and benefits that are discussed in the literature are based on notions of space, distance or related concepts like transportation costs, population density, etc. We do not use any notion of geography or space. Instead, we show that there exist fundamental reasons for suburbanization that are not related to geographical attributes of central cities and suburbs. We show in section 5.2 that transportation and migration costs do not affect the qualitative results.

We concentrate on aspects that characterize central cities and suburbs (public good provision, public debt, taxes, population changes, house prices, and rents). Suburbanization has been accompanied by other developments - most notably the segregation by income as central cities lost a disproportionate share of high-income residents. We suppress different incomes in the formal model to simplify the exposition. We show in section 5.1 that if households have different incomes, an extended model predicts that high-income households are the first to migrate to the suburbs and that low-income households concentrate in the central city. The predictions with respect to household location are similar to those of 'flight from blight' models. However, the conclusions about the causes of suburbanization are entirely different. While 'flight from blight' theories argue that different incomes and preferences cause suburbanization, this paper shows that there exists a fundamental reason for suburbanization that is independent of whether households have different incomes, preferences, etc. The paper shows that one reason for suburbanization is that homeownership rates are much higher in suburbs, that renters and homeowners prefer different policies, and that policies affect house prices.

The paper is organized as follows. Section 2 develops the model. Section 3 characterizes the equilibrium, shows how voting on local policies leads to suburbanization and the decline of central cities, and discusses the empirical evidence. Section 4 presents policy implications. Section 5 presents extensions of the model that allow to analyze other aspects of suburbanization. Section 6 concludes.

2. The Model

We consider an economy that consists of three non-overlapping regions. At the beginning of the first period, a continuum of infinitely lived households lives in every region. The mass of all households is 1.

2.1. Households

Households consume a private consumption good z, a non-durable local public good x, and durable local public good y. The units of the private and the public goods are normalized such that the prices of all goods are one. The public goods are rival and non-excludable. The variables x and y refer to the levels of public good provision. The amount of the public good, which is needed to ensure a certain level of provision, is linear in the mass of households that live in the region. Households can only consume public goods that are provided by the region in which they live. Additionally, every household consumes one unit of housing per period. For simplicity, we suppress the argument for housing in the utility function. Time is discrete and households discount future utility with $\delta < 1$. Households maximize the sum of their discounted utility,

$$\sum_{t=0}^{\infty} \delta^t (u(x_t, y_t) + z_t)$$

where $u(x, y)$ is the utility from a level x of the non-durable and a level y of the durable public good. We assume that u is increasing, continuously differentiable, and bounded from above with $u'_x(0, y) > 1 \ \forall y \geq 0$,

$u'_y(x,0) > 1 \; \forall x \geq 0$, and $u''_{ii} < 0$ and $u''_{ii} < u''_{ij}$ for $i \neq j$ and $i,j \in \{x,y\}$. The non-durable public good can only be consumed in the period in which it is provided. The durable public good depreciates at rate $1-\rho_y$, i.e., ρ_y is the fraction that does not depreciate. In every period, households receive income W. Income is used to pay taxes and rents and to buy houses and the private good. Between periods, households can costlessly migrate to another region.

2.2. Housing

Households either rent or live in a house that they own. Houses that are rented out are owned by a continuum of risk-neutral absentee landlords. Houses depreciate at rate $1-\rho$, i.e., the probability that a house still exists in the next period is ρ with $\rho > \rho_y$. The construction of a house costs c and, additionally, requires one unit of land. Land that is not used to build houses and houses that are not rented out earn in every period a rent l. At the beginning of the first period, there exists one region (the central city) in which the majority of households rent while in the other regions (the suburbs) the majority of households own a house.[5] The mass of land in a region is larger than 1.

2.3. Policies

In every period, households vote on the policy of the region in which they live. Policies specify levels of public good provision and a non-negative level of taxes τ. The winning policy is implemented. Neither households nor regions can commit to future policies. Public goods can be financed via taxes and debt. At the beginning of the first period, the levels of debt and durables are equal to zero in all regions. Since all households have the same preferences, all renters in a region prefer the same policy and, similarly, all owners prefer the same policy.

2.4. Banks

Most local jurisdictions have substantial financial obligations, e.g., public debt, underfunded pension plans, expenditures that are required by law, etc. To keep the analysis tractable, we model financial obligations as

[5] Section 5.1 relaxes the assumption that renters are the majority in the central city and shows that the qualitative results do not change.

public debt in form of bank loans. Regions and households have access to a perfectly competitive banking sector. Banks collect savings and make loans. Let i be the risk-free interest rate with $1+i = \frac{1}{\delta}$. To simplify the exposition, we assume that debt contracts are one-period contracts, i.e., the debt has to be repaid in the next period (where, of course, banks and regions can sign a new debt contract). A debt contract specifies an amount and an interest rate. Regions are local sovereigns. Hence debt contracts cannot be enforced against regions and debt contracts cannot be conditioned on the implemented policy. If a region does not meet its debt repayment obligations, banks can seize the tax receipts until the debt is repaid but banks cannot determine the policy.[6]

2.5. Timing

At the beginning of a period houses are built. Households buy and sell houses and rents are paid. After that, regions and banks sign public debt contracts and households decide how much to save and how much to consume. After debt contracts are signed, households vote and the winning policy is implemented.[7] Regions collect taxes and the transfer between regions and banks takes place. After that, regions provide public goods. At the end of the period, houses and the durable public good depreciate. After the end of the period and before the next period starts, households migrate.

Rents that are paid in the first period do not affect future policies, migration, etc. Therefore, we assume that in the first period in all regions the mass of households is equal to the mass of houses and ignore the determination of first-period rents.

[6] In equilibrium, regions do not default. We need assumptions about default procedures to determine optimal policies (i.e., debt). In reality, creditors cannot seize taxes. The crucial point is not our assumption that creditors can seize taxes but that there are some costs associated with bankruptcy. Municipal bankruptcy is much more complicated and procedures depend on state law and on the federal bankruptcy code (Chapter 9). The purpose of Chapter 9 is to provide a financially-distressed municipality protection from its creditors while it develops and negotiates a plan for adjusting its debt. §943(b)(7) of the federal bankruptcy code requires that "the plan (for adjustment of debts) is in the best interest of creditors and is feasible". Our results for the case of a default display these features (i.e, the new debt contract is in the best interest of creditors and is feasible).

[7] We assume that debt contracts are signed before households vote. Two observations motivate the timing structure: local jurisdictions are sovereigns that can not fully commit to a policy and policies are feasible only if banks provide the necessary funds. The assumption that debt contracts are signed before households vote is equivalent to the assumption that households first vote on policies and after that debt contracts are signed where banks take into account that regions can not fully commit to implement the policy that was voted for.

2.6. Assumptions

Define x^s, y^s such that $u'_x(x^s, y^s) = 1$ and $u'_y(x^s, y^s) = 1$ and define x^e, y^e such that $u'_x(x^e, y^e) = 1$ and $u'_y(x^e, y^e) = 1 - \rho_y \delta$. Note that x^s, y^s and x^e, y^e are unique. While x^s, y^s maximize utility in a one shot game, x^e, y^e are the efficient level of public good provision.[8]

Assumption 1 $W > x^e + y^e(1 - \rho_y \delta) + l + c(1 - \rho\delta)$

Assumption 1 ensures that income is large enough to finance the efficient level of public goods and to replace depreciated houses.

Assumption 2 $u(x^s, y^s) - x^s - y^s > u(x^e, y^e) - x^e - y^e(1 - \rho_y \delta) - c(1 - \rho\delta)$

Assumption 2 is a technical assumption that ensures that the difference between the utility from financing the efficient level of public goods and financing the inefficient one-shot level is not too large relative to the cost of housing. If Assumption 2 is not satisfied, the equilibrium does not change except that the population of the region with the renter majority decreases even faster.

Assumption 3 If all households in a region are indifferent between renting and buying a house, then the ratio of renters to owners is the same as in the period before.

In equilibrium, households are indifferent between renting and owning. Hence, a tie-breaking rule is necessary to determine the ratio of renters to owners. Assumption 3 reflects the fact that differences in the proportion of renters and owners between suburbs and central cities have been stable over time and that the past homeownership rate of a city is a very good predictor for future homeownership rates. The reason is that homeownership rates are to a large extent determined by the physical structure of the housing stock. Certain types of housing that are overrepresented in suburbs (e.g., single family homes) are much more prone to be owner occupied than others (e.g., large apartment complexes) that are more common in central cities. While 88% of households that live in single family detached units are owners, only 58.7% of households in attached single family units are owners and only 13.6% of households in multi-family units

[8] The levels x^e and y^e are efficient if the population of the region does not decline too fast, i.e., if the population does not decline faster that the durable public good depreciates. This is true in equilibrium for all regions and periods.

are owners[9]. Since houses are durable, the physical structure of the housing stock changes only slowly and, therefore, homeownership rates are fairly constant. We discuss in section 3.4 the incentives for households to influence homeownership rates and in section 4 the rationale for why a welfare maximizing policy maker wants to influence homeownership rates.

2.7. The Housing Market

Households consume one unit of housing per period. Hence, in every period and every region, the mass of houses is larger than or equal to the mass of households. Land that is not used to build houses and houses that are not rented out earn in every period a rent l. Since in every region the mass of land is larger than 1, land prices are the same in all regions and constant over time. Let P be the price of a unit of land with $P = \frac{l}{1-\delta}$. If houses are built, the price of a house in that region has to be equal to the total construction costs $c+P$. Hence equilibrium house prices cannot be lower than P and cannot be higher than $c+P$. Since rented houses are owned by a continuum of absentee landlords, the market for rented houses is perfectly competitive and absentee landlords earn zero profits. In equilibrium, the price of a house is equal to the discounted sum of expected rents plus the discounted price of land if the house depreciates. Let p_{jt} and r_{jt} be the house price and the rent in region j and period t. In equilibrium, p_{jt} can be written as

$$p_{jt} = r_{jt} + (1-\rho)\delta P + \sum\nolimits_{s=1}^{\infty} (\rho\delta)^s \left[E[r_{jt+s}] + (1-\rho)\delta P \right]$$

where expectations are taken at the beginning of period t when houses are sold and rent contracts are signed. Rearranging gives

$$r_{jt} = p_{jt} - \rho\delta E[p_{jt+1}] - (1-\rho)\delta P. \tag{1}$$

Hence, households are indifferent between renting or owning a house. Assumption 3 implies that majorities do not change. Four conditions hold at the equilibrium of the housing market: the mass of households in a region is smaller or equal to the mass of houses, rents are determined by eqn.(1), $p \in [P, c+P]$ with $p = c+P$ if houses are built in that region, and rents are equal to l if the mass of households is smaller

[9]Source: American Housing Survey 2003

than the mass of houses.

2.8. Migration

Households migrate to maximize their expected utility. Since migration affects house prices, house prices and, therefore, rents depend on expected policies and expected migration. There are no stochastic elements in the model, so that there is no uncertainty about equilibrium policies and migration. Therefore, we suppress the expectation operator.

The discounted future utility is a function of future policies and of the wealth of a household. Since utility is quasilinear and since $\delta(1+i)=1$, households are indifferent between saving and consuming the private good. Wealth itself affects neither migration nor the preferred policy. But of course, when households migrate or vote, they take into account how this affects their wealth. Quasilinearity of the utility function allows to add the change in wealth due to rents and taxes and the utility from public goods to derive a measure of how living in a region affects the expected discounted utility. Consider the migration decision at the end of period $t-1$. When households decide whether or not to migrate, they anticipate that, given the outcome of the migration process, regions implement the equilibrium policies. Equilibrium policies and rents depend on the population allocation, the majorities, and the stock of debt and durables. Let n denote a generic population allocation. The superscript * indicates equilibrium values. Let $r_{jt}(n), x^*_{jt}(n), y^*_{jt}(n)$, and $\tau^*_{jt}(n)$ be the rents and the equilibrium policies in region j in period t given some population allocation n, the majorities in all regions, and the stock of debt and durables which are determined in $t-1$. As shown above, in equilibrium, households are indifferent between renting and owning so suppose that the household rents in the next period. The indirect per-period utility v_{jt} is the sum of the change in wealth that results from living in region j in period t (i.e., from rents and taxes) and the utility that is derived from public goods:

$$v_{jt}(n) = u(x^*_{jt}(n), y^*_{jt}(n)) - r_{jt}(n) - \tau^*_{jt}(n).$$

Since the indirect per-period utility v_{jt} is used to analyze migration, v_{jt} is defined for all possible population allocations. Note that $v_{jt}(n)$ is evaluated at the equilibrium policies given n. While equilibrium policies are equal to the Condorcet winner and are defined for all n, equilibrium rents are not necessarily defined for all $n \neq n_t^*$. Let n_{jt} and h_{jt} be the mass of households and the mass of houses in period t in region j. Since houses that are not rented out earn a rent l, we have $r_{jt} = l$ if $n_{jt} < \rho h_{jt-1}$. If $n_{jt} > \rho h_{jt-1}$, houses are built and $p_{jt} = c + P$ and r_{jt} is determined by eqn.(1). If $n_{jt} = \rho h_{jt-1}$, the equilibrium conditions for the housing market only require that $p_{jt} \in [P, c + P]$. Therefore eqn.(1) does not determine r_{jt} exactly but defines an interval I_{jt} of possible rents. In equilibrium, households are indifferent towards migration. This condition determines a unique r_{jt}^* if $n_{jt}^* = \rho h_{jt-1}$. Since this is an equilibrium argument, it does not apply if $n_t \neq n_t^*$. Let k denote a region where $n_{kt} > \rho h_{kt-1}$ and, therefore, r_{kt} is defined by eqn.(1). If $n_{jt} = \rho h_{jt-1}$ and $n_t \neq n_t^*$, $r_{jt}(n_t)$ is defined as $r_{jt}(n_t) = \arg\min |v_{jt}(n_t) - \max\{v_{kt}(n_t)\}|$ subject to $r_{jt} \in I_{jt}$. Intuitively, this definition of r_{jt} reflects that differences in indirect per-period utilities cause migration and, thereby, put pressure on rents to adjust.[10]

Recall that migration is costless. Hence at the equilibrium population allocation, the indirect per-period utilities $v_{jt+1}(n_{t+1}^*)$ are equal across regions. Define V_{t+1}^* as the sum of discounted indirect equilibrium utilities, i.e., $V_{t+1}^* = \sum_{s=1}^{\infty} \delta^{s-1} v_{jt+s}(n_{t+s}^*)$. Consider the migration decision at the end of period $t-1$. Let V_{jt} be the sum of discounted indirect per–period utilities of a household that lives in period t in region j as a function of the population allocation:

$$V_{jt}(n) = v_{jt}(n) + \delta V_{t+1}^*.$$

Note that V_{jt} is not a standard value function since households cannot choose n to maximize V. Instead, households compare V across regions and migrate to maximize their utility.

To formalize migration, we divide the time between periods into Z intervals. In each interval, a region is randomly selected. If region j is selected, a fraction $\frac{3}{Z}$ of the population of region j migrates according to the migration rule. We consider the limit as $Z \to \infty$. Let j, k, m denote the regions. Let n be the

[10] The definition of r_{jt} if $n_{jt} = \rho h_{jt-1}$ and $n_t \neq n_t^*$ is a purely technical assumption to ensure that rents are well-defined everywhere. The assumption does not affect the results.

population allocation at some point during the migration process. Consider the migration between period $t-1$ and t.

Migration Rule: Households migrate from region j to region k if $V_{jt}(n) < V_{kt}(n)$ and $V_{mt}(n) < V_{kt}(n)$. If $V_{jt}(n) < V_{kt}(n) = V_{mt}(n)$ households leave region j and split equally among k and m. Otherwise households stay in j.

According to the migration rule, households migrate myopically in the sense that they evaluate future utilities at the equilibrium strategies but do not anticipate that additional households migrate. In equilibrium, indirect utilities have to be equal across regions. Therefore, the migration rule is equivalent to the assumption that rational households with perfect foresight migrate to maximize their utility.

2.9. Public Debt and Endogenous Debt Limits

There exist various kinds of restrictions on the debt of local jurisdictions. The model suppresses exogenous debt limits to highlight that regions face endogenous debt constraints since banks have to accept debt contracts. We discuss exogenous debt limits in section 3.3. Since banks are perfectly competitive, they accept all debt contracts that yield non-negative profits. Let D_{jt-1} be the per-capita debt of region j at the end of period $t-1$. In period t region j has to repay the last period debt plus interest and takes out new per-capita debt D_{jt}. Public debt is the liability of a region and is not enforceable against households. Households can migrate to avoid the high taxes that are necessary to serve a high debt. Hence, when banks decide which debt contracts they accept, they consider how public debt affects equilibrium policies and migration. Specifically, banks take into account that the burden of interest and principal does not become so high that all households prefer to migrate to other regions. Whether region j indeed fulfills its debt repayment obligations in period t depends on two factors:

- the winning policy in t
- the new debt contract D_{jt}

The first point reflects the fact that regions are local sovereigns and, therefore, households are free to vote for a policy such that the region does not meet its debt repayment obligations. With respect to the second point, recall that banks accept all debt contracts on which they make non-negative profits. To take both points into account, we use the following definition of default:

Definition 1 (Default) Region j is in default if there exists no policies that are consistent with utility maximizing households that migrate according to the migration rule such that region j meets its debt repayment obligations, banks make non-negative profits on new debt contracts, and $D_{jt} < \infty \forall t$.

Proposition 1 below shows that the equilibrium strategy of banks can be described by a debt limit $D_{jt}^{\max} > 0$ such that banks accept in period t all debt contracts of region j with $D_{jt} \leq D_{jt}^{\max}$. To simplify notation, we denote the debt limit by $D_{jt}^{\max}$, although, in general, the debt limit depends on the population allocation. In equilibrium, regions do not default. However, default procedures are important because they determine $D_{jt}^{\max}$. We discuss the effect of default procedures in section 3.3. Proposition 1 below shows that if a region defaults, then banks reduce the debt such that the region is no longer in default. Hence no region is in default when households vote.

3. Suburbanization

Since no region is in default when households vote, it follows from Definition 1 that households vote for policies such that regions meet their debt repayment obligations. When banks decide, which debt contracts they accept, they anticipate future policies and migration. Since there are no stochastic elements in the model, there is no uncertainty about equilibrium policies and migration and, in equilibrium, regions do not default. Hence banks charge the risk-free interest rate i, and the net per-capita transfer in period t from region j to banks is $(1+i)D_{jt-1}\frac{n_{jt-1}}{n_{jt}} - D_{jt}$. Then, in equilibrium, the budget constraint

$$x_{jt} + y_{jt} - \rho_y y_{jt-1}\frac{n_{jt-1}}{n_{jt}} \leq \tau_{jt} - (1+i)D_{jt-1}\frac{n_{jt-1}}{n_{jt}} + D_{jt} \qquad (2)$$

is satisfied for all j and t. In period t, renters in region j vote for the policy that maximizes

$$u(x_{jt}, y_{jt}) - \tau_{jt} + \delta V_{t+1}^{*}$$

subject to eqn.(2), to $y_{jt} \geq \rho_y y_{jt-1} \frac{n_{jt-1}}{n_{jt}}$, and to the constraint that banks accept the debt contract D_{jt}. Owners take the effect of the policy on the price of their house into account. Owners vote for the policy that maximizes

$$u(x_{jt}, y_{jt}) - \tau_{jt} + \delta V^*_{t+1} + \rho\delta p_{jt+1}$$

subject to the same constraints as above.

Ex ante, regions differ only in their majorities. Assumption 3 implies that majorities do not change in equilibrium. Since policies are determined by the majority, we refer to the region with a renter (owner) majority as renter (owner) region. Proposition 1 describes the equilibrium of the dynamic game. We state equilibrium strategies in the form of policies that are implemented in equilibrium. Equilibrium policies and outcomes are indicated by superscript *. The subscripts o and r indicate owner and renter regions, the subscript t indicates the time period.

Proposition 1. *(i) In equilibrium, the population of the owner regions increases. Owner regions provide in all periods the efficient level of public goods,* $x^*_{ot} = x^e$ *and* $y^*_{ot} = y^e$ $\forall t$. *Taxes, public debt, house prices and rents are constant over time, with* $\tau^*_{ot} = x^e + (1 - \rho_y \delta) y^e$, $D^*_{ot} = \rho_y \delta y^e$, $p^*_{ot} = c + \frac{l}{1-\delta}$, *and* $r^*_{ot} = (1 - \rho\delta)c + l$ $\forall t$.

(ii) The population of the renter region decreases, $n^*_{rt} = \rho^{t-1} n_{r1}$. *For all* $t > 1$, $p^*_{rt} = \frac{l}{1-\delta}$, $r^*_{rt} = l$, *and* $D^*_{rt} = D^{\max}_{rt}$. *In the first period,* $u'_x(x^*_{r1}, y^*_{r1}) = u'_y(x^*_{r1}, y^*_{r1})$ *and* $x^*_{r1} + y^*_{r1} = \max\{D^{\max}_{r1}, x^s + y^s\}$ *and* $\tau^*_{r1} = \max\{0, x^s + y^s - D^{\max}_{r1}\}$. *For* $t > 1$, $u'_x(x^*_{rt}, y^*_{rt}) = 1$, $y^*_{rt} = \max\left\{y^s, \frac{n_{rt-1}}{n_{rt}} \rho_y y_{rt-1}\right\}$, *and* $\tau^*_{rt} = x^*_{rt} + \max\left\{0, y^s - \frac{n_{rt-1}}{n_{rt}} \rho_y y_{rt-1}\right\} + \frac{(1+i)D_{rt-1} n_{rt-1}}{n_{rt}} - D^{\max}_{rt}$. *There exists* $T < \infty$ *such that* $y^*_{rt} = y^s$, $x^*_{rt} = x^s$, $\tau^*_{rt} = \tau^*_{rT}$, *and* $D^*_{rt} = D^{\max}_{rT}$ *for all* $t \geq T$.

(iii) For every region j *and period* t, *there exists a maximum per-capita debt* $D^{\max}_{jt} > 0$ *such that banks accept debt contracts if and only if* $D_{jt} \leq D^{\max}_{jt}$. *For owner regions,* $D^*_{ot} < D^{\max}_{ot}$ $\forall t$. *For the renter region,* $D^*_{rt} = D^{\max}_{rt}$ $\forall t$. *Banks charge the risk-free interest rate. In equilibrium, regions do not default. If a region is in default, banks cancel the minimum amount of debt such that the region is not in default anymore.*

The proof is relegated to the appendix.

In the remainder of the section, we discuss the results of the model and relate them to the empirical observations. Since the percentage of renters in central cities is much higher than in suburbs, we refer to regions with renter (owner) majority as central city (suburb) when we discuss the empirical evidence and when we derive policy implications.

3.1. Homeownership Rates and Expenditures on Public Goods

Proposition 1 shows that suburbanization and the decline of central cities can occur even when all households have the same preferences, the same income, and when the spatial distribution of jobs and residences does not matter. One reason for suburbanization and the decline of central cities are differences in the local policies. Local policies differ because the percentage of renters is much higher in central cities than in suburbs. The different percentages of renters in central cities and suburbs do not only explain migration but also why central cities provide public goods inefficiently and why debt and taxes are high relative to the utility from public goods.

When owners vote, they take the effects of debt and durable public goods on house prices into account. Proposition 1 shows that owner regions provide the efficient level of public goods. Contrary to owners, renters are neither affected by the negative effect of debt on house prices nor can they capture the positive effect of durable public goods. This is the reason why the renter region (except for possibly the first periods) underprovides the durable public good and takes out the maximum debt that banks approve. Non-durable public goods do not affect future house prices. Therefore, the renter region provides the efficient level (except for possibly the first period). Note that the results about public good provision in the renter region in the first periods are driven by the assumption that regions have zero debt and no durable public goods at the beginning of the first period.

Although the percentage of renters and owners differs drastically and systematically between central cities and suburbs, renters are only in a few central cities the majority. To simplify the exposition, we assume that all households have the same quasilinear preferences and that regions have different majorities. If preferences are not quasilinear and households differ along several dimensions (i.e., homeownership, preferences, income), one would expect that an increase of the homeownership rate causes a gradual change of policies. The empirical analysis of the effect of homeownership rates on local policies is complicated by the fact that high expenditures on public goods can be the result of high costs or of an inefficient provision instead of a high level of public goods.[11] Additionally, certain public services are in some areas provided by cities and in others by special districts where special district boundaries in many cases do not coincide with city boundaries. There are few studies which estimate the effect of homeownership rates on local expenditures for durable and non-durable public goods. DiPasquale and Glaeser (1998) and Monroe (2002) use data from the Census and the Census of Governments. DiPasquale and Glaeser find that - both on city and county level - homeownership reduces total expenditures, increases the share of expenditures for highways, and reduces the share of expenditures for welfare. On the city level, homeownership has a very small negative effect on the share of expenditures for education while this effect is much stronger and positive on the county level. Similar, Monroe finds that homeownership increases the share of expenditures on durable public goods (sewers, roads, and parks) and reduces welfare spending.[12] Glaeser and Shapiro (2002) use local public finance variables from the City and County Data Book. They find that homeownership reduces per capita expenditures and reduces the share of spending on welfare. They also report that homeownership reduces spending on health and hospitals and increases spending on highways. While we assume that taxes have to be non-negative, welfare spending (i.e., negative taxes) is of course an example for a non-durable public good because it benefits some of the current residents but does not affect future house prices. Haughwout (1993) emphasizes the different attitudes of renters and owners towards public investment in infrastructure (i.e., durable public goods). He uses two variables to measure the effect of homeownership rates on the percentage of spending that is allocated to investment. He finds a strong positive and highly significant effect if the median voter is a homeowner and a positive but insignificant effect for the percentage of homeowners. If the dummy variable for the median voter is excluded, the percentage of homeowners has a positive and highly significant effect on the share of spending that is

[11] Many types of public capital (e.g., roads, bridges, buildings) have well-defined best practice maintenance paths. Owners prefer a best practice maintenance policy. Renters prefer that maintenance is deferred although this leads to exceedingly high repair or replacement costs at a later date.

[12] Monroe reports somewhat different results when FHA loan conditions are used as instruments for homeownership. With instrumental variables, homeownership reduces spending on roads, sewers, and parks and in one of the IV specifications, homeownership increases spending on welfare. The problem with this approach is that the instruments suffer from endogeneity. Specifically, if local policies (i.e., spending on durable public goods) are (partly) capitalized in house prices, then the instruments (e.g., percentage of houses which are affordable under FHA criteria) are functions of the dependent variable.

allocated to investment.

These studies analyze the effect of homeownership rates but do not distinguish between central cities and suburbs. Similarly, in our model, regions are initially identical except for majorities. In reality, a large share of the public capital is concentrated in central cities. For example, the per-capita capital stock related to mass transportation is much higher in central cities, roads in central cities are more heavily used by suburban residents than vice versa, etc. Since we suppress these issues in the model, the results of the model are not predictions about the absolute capital stock or the absolute expenditures on infrastructure but on capital stock and expenditures relative to the efficient level.

3.2. House Prices, Migration, and the Durability of Houses

Besides policies, regions also differ in terms of rents, house prices, and population growth. House prices are lower in the renter region because renters do not take the effect of public goods and debt on house prices into account. Households anticipate that renter regions provide public goods inefficiently and that taxes in the renter region are high to serve the debt. Since migration is costless, the equilibrium indirect utilities from living in a region have to be equal. Therefore, rents in the renter region have to be lower. Rents are bounded from below by l because houses are used for other purposes (e.g., offices) if rents are even lower. The lower bound on rents together with the equilibrium public good provision and the condition that equilibrium indirect utilities are equal determine the maximal tax that a region can levy and, therefore, determine the maximal debt $D_{rt}^{\max}$ that the region can repay. Since $D_{rt}^{*} = D_{rt}^{\max}$, house prices in the renter region are equal to $\frac{l}{1-\delta}$ with $\frac{l}{1-\delta} = P$. Since house prices are below the total construction costs $c + P$, no new houses are built in the renter region. While house prices in the renter region are determined by the opportunity cost of houses and land, house prices in the owner regions are equal to total construction costs. The analysis of the housing market shows that the reason for suburbanization is independent of whether households have different incomes, preferences, etc. Rents in the central city are so low (relative to construction costs and the price of land) that it is not profitable to construct residential housing. Over time, households migrate to the suburbs because houses depreciate and no new houses are built in the central city. We show in section 5.1 that different incomes do not cause migration but only determine which households migrate to the suburbs.

In reality, houses are built in central cities albeit in much smaller numbers than in the suburbs. The result that no houses are built is due to the assumption that the housing supply is perfectly elastic. We show in section 5.4 that the central city population can stagnate or even increase (but at a lower rate than the population of the suburbs) if the housing supply is an increasing function of the house price.

This relation between house prices, depreciation, and migration has been documented by Glaeser and Gyourko (2005). Glaeser and Gyourko analyze how the durability of houses influences the effects of exogenous shocks on urban growth and decline. Using data from 321 cities, they estimate the relation between population growth and the percentage of housing that is priced below construction costs. They find that for every 10% more of the housing stock that is valued below construction costs, the population growth rate decreased by 2.7%. The most extreme case in 1990 was Detroit where 96.3% of single family houses were valued below construction costs (excluding the cost of land) and 88.5% were valued at least 20% below construction costs. In our model, equilibrium house prices in owner regions are constant and equal to $c + P$ independently of how many households migrate to the owner regions. House prices in the renter region are lower and equal to P although in every period, the population declines only by a fraction $1 - \rho$. Glaeser and Gyourko find exactly this asymmetric relation between house prices and population changes. They document that even a rapid increase of the population has little effect on house prices but that house prices can fall steeply although the decline in population is small.

The model highlights the importance of the durability of houses for local policies. Since houses are durable, the downward adjustment rate of the housing stock equals the depreciation rate of houses except if house prices are so low that it is profitable to use residential houses for other purposes. If house prices are below total construction costs, no new houses are built and the population is determined by the depreciation of the housing stock. Only if house prices are equal or above total construction costs, houses are built, and the population growth determines how fast the housing stock grows. The durability of houses is the reason why the direction of causality between population change and evolution of the housing stock switches and why the housing supply is inelastic if house prices are below total construction costs. The durability of houses has two effects on local policies:

1) since houses are durable and immobile, homeowners vote for the efficient policy

2) the durability of houses makes inefficient policies and a high per-capita debt sustainable.

To see the second effect, note that only because houses are durable, house prices can drop below total construction costs. If the policy of a region is inefficient or if its debt is high, the utility from living in this region (i.e., from public goods and taxes) is low relative to the utility from living in other regions. Unless rents and house prices are lower, all households migrate to some other region. Since houses are durable, house prices can drop below total construction costs, i.e., below house prices in other regions where the population grows. If policies are inefficient, house prices and rents drop while the population adjusts over time as houses depreciate. Hence, the durability of houses makes inefficient policies and high debt sustainable because it ensures that the population of a region does not drop to zero although migration costs are zero. To formalize the argument, suppose that houses in the renter region are not durable but depreciate after one period. Let the adjusted construction costs in the renter region be equal to $(1-\rho\delta)c$. Recall that by assumption, households cannot choose where to live in the first period. Then in equilibrium, $x_{r1} = x^s$, $y_{r1} = y^s$, $D_{r1}^{\max} = 0$, and $n_{rt} = 0$ for all $t > 1$. Hence the population drops to zero after the first period and the inefficient policy is not sustainable.

Our model predicts that rents and house prices are lower in central cities (i.e., in renter regions) than in suburbs (i.e., owner regions). Obviously, the price of land in central cities is not necessarily the same as in suburbs. Our results concerning rents and house prices should be interpreted as rents and house prices in central cities being lower relative to construction costs plus price of land. Gyourko and Saiz (2003) find that in most MSAs the percentage of houses that are priced below 90% of the construction costs is much larger in central cities than in suburbs. All MSAs where the percentages were approximately equal had a very small percentage of houses priced below the 90% limit. Their measure of construction costs does not include the price of land. Since land is usually cheaper in suburbs, the difference in the percentage of houses that are priced below construction cost plus price of land is probably even larger. Similarly, Mills and Simenauer (1996) do not include land prices. They find that constant quality house prices are 11.5% higher in suburbs.

Equilibrium policies of owner regions are independent of the mass of households that immigrate. Hence, the equilibrium does not change if the migration rule specifies that households migrate to a particular region if they are indifferent. The relevant prediction of our model with respect to the population of owner regions is that for all owner regions $n_{jt} \geq \rho n_{jt-1}$ and that the total mass of households that live in owner regions increases. Therefore, our results are in line with the findings of Lucy and Phillips (2003) who report that in the 1990s the population was stagnant or decreasing in $\frac{1}{3}$ of the suburbs of the most populous metropolitan areas. To simplify the exposition, we consider the simplest model with three regions. Many MSAs have several central cities and more than two suburbs. Equilibrium policies, debts, rents, house prices, and migration do not change if there exists more than one renter region or more than two owner regions.

3.3. The Effect of Public Debt

The model highlights the importance of debt for the efficient provision of public goods. In our model, debt includes all financial obligations of a region, e.g., public debt, underfunded pension plans, expenditures that are required by law, etc. Regions have two kinds of assets: durable public goods and financial assets (i.e., debt). In equilibrium, $\rho_y y^*_{ot} - D^*_{ot}(1+i) = 0 \; \forall t$, i.e., at the beginning of a period, the value of the 'net-assets' of an owner region is zero. This implies that the utility from living in an owner region is not affected by immigration. If the population of a region grows independently of current policies, lowering the current tax by ϵ increases the per-capita debt at the beginning of the next period by less than $\epsilon(1+i)$. In this case, all households prefer to lower the current tax and increase the debt. However, if $\rho_y y - D(1+i) < 0$, owner regions compete for immigrants, since the positive effect of sharing the debt with more households outweighs the negative effect of the crowding of the durable public good. This competition is the reason that, in equilibrium, $\rho_y y^*_{ot} - D^*_{ot}(1+i) = 0 \; \forall t$. The result that net-assets of owner regions are exactly zero is driven by the assumption that the cost of public goods is linear in the mass of households. The bottom line of the result is that owners vote for policies such that the marginal effect of immigration on the utility of owners is zero.

Relative to the level of the durable public good, renter regions have higher debt than owner regions, i.e., $\rho_y y^*_{rt} - D^*_{rt}(1+i) < 0$ for all t. In the renter region, the positive effect of immigration via a decrease of the per-capita debt outweighs the negative effect of the additional crowding of the durable public good.

Although the renter region would benefit from immigration, its population decreases because $p_{rt} < c + P$ and, therefore, no houses are built.

There exist various kinds of restrictions on the debt of local jurisdictions in the U.S. The model suppresses exogenous debt limits to highlight that regions face endogenous debt constraints since banks have to accept debt contracts. The endogenous debt constraints are determined by the equilibrium policies, the evolution of the population allocation, and the profit maximization of perfectly competitive banks. While debt limits reduce the probability of fiscal stress, they do not change the reasons for the inefficient public good provision in renter regions. Consider debt limits that impose some upper bound on the per-capita debt. If owner regions face a binding debt limit, they provide in every period an inefficiently low level of durable public goods. A debt limit that binds for the renter region affects at most the public good provision in the first periods but it does not mitigate the inefficient provision in the long-run. And while such a debt limit leads to higher rents and house prices in the renter region, it affects neither policies or house prices in owner regions nor the migration from the renter to the owner regions. While simple restrictions on the per-capita debt are ineffective, we propose in section 4 a rule that relates changes of the per-capita debt to changes in the provision of public goods. Under this rule, all regions provide public goods efficiently. If there are no debt limits, the renter region takes out the maximal debt $D^{\max}$ and sets taxes to maximize the tax revenue. If a binding debt limit exists, taxes are below the revenue maximizing level. Although various kinds of debt limits exist, there is evidence for some central cities that taxes are close to the revenue maximizing level (Inman, 1992, Haughwout et al., 2004).

In our model, regions do not default in equilibrium since there are no stochastic shocks. In reality, defaults of municipalities occur but are rare. Litvack and McDermott (2003) report cumulative default rates for tax backed general purpose bonds of around 0.4% and cumulative default rates for traditional revenue backed bonds (transportation and utilities) of around 0.05%.[13] Given the small number of defaults, it seems to be a reasonable simplification to assume that there are no stochastic shocks and, therefore, no defaults in equilibrium. But since the maximal debt is determined by the payoffs that are realized if a

[13] Default rates are higher for municipal bonds issued on behalf of corporations or by municipal entities that are vulnerable to corporate risks.

region defaults, it is necessary to analyze default procedures.

To model default costs, we assume that banks have the right to seize the tax revenue if a region defaults. Proposition 1 shows that if a region defaults, then banks reduce the debt by the minimal amount such that the region is no longer in default. To see the intuition, consider the end of period $t-1$ before households migrate. Suppose that region j is in default. Households and banks anticipate that the region will fail to meet its debt repayment obligation unless the debt is reduced. If region j indeed fails to meet its debt repayment obligation in t, then banks can seize the tax revenue. From Definition 1 follows that it cannot be optimal for households to vote for taxes that are higher than the outstanding debt. Hence banks seize the complete tax revenue. Households anticipate this and will either all migrate to a different region or vote for $\tau_{jt} = 0$. In the latter case, the cost of a default for households is the disruption of the provision of public goods. The only way how banks can ensure that at least part of the debt is repaid is via a commitment not to seize the complete tax revenue. Banks reduce the debt by the minimal amount that ensures that the region is not in default anymore. The strategic reduction of the debt serves as commitment of banks not to seize the tax revenue. Once the region is not in default anymore, households vote for positive taxes and the reduced debt can be served. Hence if a region defaults, banks recover only part of their debt.[14]

3.4. Zoning

Most of the literature on zoning focuses either on the use of zoning regulations as a way to attract households with a high tax-to-service ratio via imposing a minimum housing consumption or on zoning regulations as a way to restrict the supply of new houses and thereby to increases house prices. Our model shows that there exists an additional reason for zoning regulations. Certain types of housing are mostly inhabited by renters, others are mostly owner occupied. While 88% of households that live in single family detached units are owners, only 58.7% of households in attached single family units are owners and only 13.6% of households in multi-family units are owners[15]. Renters prefer a different policy than owners and as a result, house prices are lower in renter regions. Therefore, owners do not want the majority to change from

[14] Litvack and McDermott (2003) report an average recovery rate for municipal bonds of 67% which is much higher than the average recovery rate of around 40% for corporate bonds.

[15] Source: American Housing Survey 2003

owners to renters. Zoning regulations (e.g., minimum lot sizes or restrictions on the level of residential development density) are an effective instrument to control which types of housing are built and, therefore, can be used to ensure that renters do not become the majority.

4. Policy Implications

Our model shows that one reason for suburbanization is that central cities provide public goods inefficiently because they have a large percentage of renters and renters prefer an inefficient allocation of public goods. We do not attempt analyze the cost and benefits of sprawl or to determine the optimal population allocation. Therefore, policy implications refer to the mitigation of inefficient policies and not to the stop or reversal of suburbanization. We have shown in section 3.3 that debt limits are ineffective because renters prefer an inefficient allocation of public goods. Two policy instruments that are used to influence local policies are standards for the provision of public goods and grants which lower the cost of public goods for local governments. Under very strong assumptions, grants and standards can eliminate the inefficient provision of public goods. Most authors are sceptical whether these assumptions are realistic and there exists a large literature that discusses problems of grants and standards (e.g., lobbying, asymmetric information about preferences, free-riding, fly-paper effect, etc.).

There are two ways to solve the problem of inefficient public good provision. The first is to increase homeownership rates, the second is a simple accounting rule that ties changes of the per-capita debt to changes in the provision of public goods.

Encouraging homeownership has long been a policy objective in the United States[16] and huge amounts have been spent to encourage homeownership. In 2005, tax expenditures for the deductibility of mortgage interest and property taxes on owner occupied homes amount to more than $85 billion. Tax expenditures for the exclusion of capital gains taxes on home sales amount to more than $36 billion[17]. Sinai and Gyourko

[16] See, for example, <http://www.whitehouse.gov/infocus/homeownership/> and: U.S. Dept. of Housing and Urban Development: The national homeownership strategy: partners in the American dream, 1995, Washington, D.C.

[17] There are also provisions in the tax code that favor rental housing (e.g., exception of passive loss rules for rental losses, credit for low-income housing, and accelerated depreciation of rental housing). The tax expenditures for these measures amount only to $8.9 billion.
Source: Statistical Abstract of the United States 2006, Table 469

(2004) estimate that the real cost of tax subsidies for homeownership was $420 billion in 1999. Our model shows that these enormous efforts to increase homeownership should be concentrated at inner cities, or more general, on jurisdictions with a large fraction of renters.

The main political motivation for encouraging homeownership and the main topics of scholarly interest are private benefits of homeownership (e.g. educational outcomes of children, life satisfaction, financial stability) and social benefits (e.g. neighborhood stability, community involvement, likelihood to maintain the property)[18]. This paper shows that there exist additional benefits from increasing homeownership. If increasing homeownership leads to a change of the majority, then it leads to a change of local policies and to a Pareto-improvement. Owner regions provide public goods efficiently regardless of past policies. Hence, if the majority changes from renters to owners, then the region starts to provide the efficient level of public goods. House prices, policies, rents and, therefore, the indirect per-period utility in the other owner regions do not change. Therefore, efforts to increase homeownership should be concentrated on the renter dominated central cities instead of mainly subsidizing homebuyers in owner dominated suburbs as is current practice. The result that policies change if and only if the majority changes is due to the assumption that all households have the same preferences. We show in section 5.1 that an increase of the homeownership rate causes a gradual shift towards a more efficient provision of public goods if households differ along several dimensions (e.g., homeownership, preferences, income).

Increasing homeownership rates changes the composition of the electorate but does not restrict the set of feasible policies. A different way to achieve efficient public good provision is via a rule that ties changes of the per-capita debt to changes in the provision of public goods. Let $A_j = \rho_y y_{jt-1} - D_{jt-1}(1+i)$, i.e., A_j is the value of the 'net-assets' of region j at the beginning of period t. Consider a rule that specifies that $\rho_y y_{js} - D_{js}(1+i) \geq A_j$ for all $s \geq t$. It is straightforward to show that under this rule, all regions provide the efficient level of public goods regardless of their respective majorities.[19] This rule combines two aspects. The first is the standard concept that current residents pay only for what they consume.

[18] See, for example, DiPasquale and Glaeser (1998), Rohe et al. (2001), Rossi and Weber (1996), Green and White (1997)

[19] Under this rule, for an extra dollar spent on y, regions need to finance only $1-\rho_y\delta$ via taxes. It follows immediately that the renter region provides x and y such that $u'_x = 1$ and $u'_y = 1-\rho_y\delta$. Banks will accept the higher per-capita debt of the renter region. The policy of the owner regions does not change.

The second is the commitment aspect. The rule commits regions to use additional debt only to finance the provision of the durable public good.[20] Only because of this commitment are banks willing to provide additional credit to the renter region. The advantage of this rule is that the current financial situation is taken as starting point. Hence no transfers are necessary to implement this rule.

5. Extensions

We have shown above that the systematic difference between the homeownership rates of central cities and suburbs and the fact that renters and owners prefer different policies cause suburbanization. The analysis concentrates on aspects that characterize central cities and suburbs rather than their residents: population growth, the efficient/inefficient provision of public goods, public debt, taxes, and house prices. Obviously, suburbanization includes other important aspects which are suppressed in the model above. One advantage of the model is that it generates explicit solutions which makes it straightforward to extend the model to analyze other aspects of suburbanization. In this section, we discuss several extensions and their results.

5.1. Income Heterogeneity and Different Percentages of Renters instead of Different Majorities

The assumption that households have homogenous quasilinear preferences and that renters are the majority in central cities is an idealization that allows to determine policies via the Condorcet winner. Although the difference between the ratio of renters to owners in central cities and suburbs is huge and constant over time, renters are the majority only in some central cities. And of course, preferences are not homogenous and incomes matter because preferences are not quasilinear. Hence there exist many groups that differ by income, preferences, and by whether they rent or own. Suppose that the implemented policy is a weighted average of the policy that each group prefers where weights are determined by the relative mass of each group. To relate implemented policies to the optimal levels of public goods, define the efficient level of public goods as the weighted average of the efficient levels across groups.

[20] Debt restrictions and debt policies vary widely across cities. Miranda et al. (1997) report that many cities have policies that state that debt should not be used to finance current expenditures but only for infrastructure investments.

Our model shows that suburbanization occurs even if incomes are the same. In reality incomes differ and one of the most prominent aspects of suburbanization is that central cities have systematically lost high-income residents. Accordingly, most of the literature on suburbanization analyzes some kind of sorting along income. Consider a situation where at the beginning of the first period the distribution of preferences and incomes is the same for all regions and where the percentage of renters is higher in the central city. Suppose that the marginal utility of the durable public good increases in the consumption of the private good. Renters prefer a higher level of public debt and a lower level of the durable public good than owners who have the same income and the same preferences. If the implemented policy is a weighted average of the policy that each group prefers, then all regions provide an inefficient level of the durable public good but the underprovision is more severe in the central city and the public debt is higher. Hence rents are lower in the central city and, therefore, no houses are built and the population decreases.[21] In equilibrium, $V_{rt}^* = V_{ot}^*$ holds for the marginal household. After the first period, households migrate in both directions. Low-income households migrate from the suburbs to the central city while high-income households migrate from the central city to the suburbs. In later periods, the households with the highest income leave the central city as houses depreciate and migrate to the suburbs. Households in the central city prefer a low level of durable public goods (due to the sorting of households) and, additionally, the underprovision of the durable public good is more severe in the central city. Note that policies are not constant over time since migration affects the income distribution and, therefore, the implemented policies. The argument with respect to migration and sorting is similar for heterogeneous preferences or if taxes depend on income.

If households are credit-constrained such that homeownership is beyond the reach of the poor or if high-income households benefit more from tax subsidies for homeownership, then the sorting along income reinforces the renter dominance in the central city and the owner dominance in the suburbs. Note that households migrate because house prices in the renter dominated central cities are so low that no or only few houses are built. Whether incomes differ has no effect on the net-migration from central cities to suburbs but determines only which households migrate. This shows that suburbanization is driven by the

[21] The result that no houses are built is driven by the assumption that the housing supply is perfectly elastic at $p + c$. Section 5.4 discusses the case when the housing supply is an increasing function of the price.

fact that the percentage of renters is much higher in central cities and that it is not crucial whether renters are indeed the majority in the central city or that all households have the same income and homogeneous preferences.

5.2. Transportation and Migration Costs

Suburbanization is associated with sprawl since central cities usually have a higher population density. The costs of sprawl are primarily determined by transportation costs. Depending on where jobs are located, inefficiencies arise from a suboptimal allocation of households across regions. Under the standard assumption, jobs are located in the central city. Let $c_T > 0$ be the per-period transportation costs from the suburbs to the central city. In equilibrium, the indirect per-period utilities v_{jt} differ by c_T. If households face additionally migration costs c_M, then equilibrium indirect per-period utilities differ by $c_T + (1-\delta)c_M$. If c_T and c_M are not too high, equilibrium policies do not change. Note that $D_{rt}^{\max}$ increases in c_T and c_M. Since the qualitative results of our model do not depend on c_T and c_M, it is straightforward to include transportation and migration costs to model the spatial dimension of an MSA and to analyze potential welfare gains or losses due to the migration to the suburbs.

5.3. Property Taxes

In 2002, property taxes accounted for 24.9% of the total revenue of local governments and for 72.9% of the total revenue from taxes.[22] The qualitative results of our model do not change when regions levy property taxes. Expectations about future local policies affect house prices and, therefore, affect the house values that are determined by tax assessors. Note that if a region implements a different policy than what was expected, then house prices adjust but house values (i.e., the tax base) do not change before the next reassessment. Hence when households vote on taxes and public goods, house values are already realized. For simplicity, assume that house values are equal to the house prices at the beginning of the period.

Suppose that regions finance public goods via debt and property taxes. Let τ be the tax rate that is levied on houses. The situation is essentially the same as under a lump-sum tax. Owners take the effect of

[22] Source: 2002 Census of Governments

debt and durable public goods on future house prices into account when they vote. Hence owner regions provide public goods efficiently. As in the original model, the value of net-assets $D^*_{ot}(1+i) - \rho_y y^*_{ot}$ is zero since owner regions compete for immigration. In equilibrium, house prices, taxes, rents, and public debt in owner regions are constant over time with $p^*_{ot} = c + \frac{l}{1-\delta}$, $\tau^*_{ot} = \frac{x^*_{ot}+(1-\rho_y\delta)y^*_{ot}}{p^*_{ot}}$, $r^*_{ot} = c(1-\rho\delta) + \tau^*_{ot}p^*_{ot}$, and $D^*_{ot} = \rho_y\delta y^*_{ot}$.

Contrary to owners, renters do not take the effect of policies on future house prices into account. Since house values (i.e., the current tax base) are determined before households vote, renters vote to maximize tax revenues in order to maximize the utility from public goods. In reality, there are both explicit limits on property taxes (e.g., Proposition 13 in California) and implicit limits (taxes cannot be so high that owners and landlords prefer to tear down their houses to avoid taxes). Regardless of what limits taxes, renters prefer the same inefficient allocation of public goods as in the original model (i.e., such that marginal utilities are equal subject to $y_{rt} \geq \rho_y y_{rt-1}\frac{n_{rt-1}}{n_{rt}}$). Hence the renter region underprovides the durable public good and $D^*_{rt} = D^{\max}_{rt}$. House prices are below construction costs plus price of land but can be larger than $\frac{l}{1-\delta}$. Hence, no new houses are built in the renter region and $n^*_{rt} = \rho n_{rt-1}$ because households migrate to the owner regions as houses depreciate.

The tax base (i.e., the assessed house value) is a function of the house price which depends on the expected policies. Two aspects of the political system are important for the results. The first is that once taxes are collected, the assessed house values are not corrected if the region implements a different policy than what was expected. The second aspect is that regions cannot commit to implement certain policies. In reality, partial commitment is possible in some cases (long-term projects). A continuum of equilibria exists if the renter region can perfectly commit to implement some policy in the next period.[23]

5.4. Stagnating or Increasing Central City Population and Elastic Housing Supply

While the population of most central cities declined between 1950 and 1990, most central cities experienced small population gains in the 1990s while suburbs experienced much larger population gains. The crucial

[23] Note that the case of perfect commitment is equivalent to the assumption that in every period house prices (and, therefore, rents), taxes, and public good provision are determined simultaneously.

observation with respect to the development of the population allocation is that house prices (relative to construction costs and the price of land) are higher in the owner dominated suburbs because owners take the effect of policies on house prices into account. The result in Proposition 1 that no houses are built in the central city is driven by the simplifying assumption that the supply of housing is perfectly elastic. In reality, houses are built in central cities albeit in much smaller numbers than in the suburbs. Suppose that in every region, the supply of new houses is an increasing function of the price. As shown above, house prices (relative to the price of land) are higher in the owner dominated suburbs. If the housing supply function is the same in all regions, then less houses are built in the central city than in the suburbs. In most central cities, land is more scarce than in the suburbs which means that even less houses are built compared to the situation where the housing supply is the same in all regions. The results about the efficient provision of public goods in the owner regions and the inefficient provision in the renter regions do not change. If the total population increases, it is possible that the population in the central city increases but at a lower rate than in suburbs.

5.5. Absentee Landlords

The assumption that rented houses are owned by absentee landlords is common but unsatisfactory since part of the payoffs are attributed to agents outside the model. Consider the model above except that rented houses are owned by competitive investment funds and each household owns the same portfolio of shares of funds. The qualitative results are similar. The equilibrium policy of owner regions and the equilibrium strategies of banks are the same as in Proposition 1. Renters take the positive effect of the durable public good and the negative effect of debt on the price of funds into account. The level of the durable public good in the renter region is strictly decreasing because the population of the renter region decreases and, therefore, the weight of houses in the renter region on the price of funds decreases. Banks anticipate that renters take the effect of the policy on the price of funds into account. Hence $D_{rt}^{\max}$ is higher compared to the situation where rented houses are owned by absentee landlords. Depending on the initial assumptions, it is possible that $D_{rt}^{*} < D_{rt}^{\max}$ and $r_{rt}^{*} > l$ in the first periods but there always exists $T < \infty$ such that $D_{rt}^{*} = D_{rt}^{\max}$ and $r_{rt}^{*} = l$ for all $t \geq T$. House prices in the renter region are so low that no new houses are built. Therefore, households migrate to the owner regions as houses depreciate.

6. Conclusion

Suburbanization has been the dominant feature in the development of large cities in the United States. Most attempts to explain suburbanization concentrate on attributes of central cities and suburbs (location of jobs, access to highways, ethnic and social diversity, etc.) or on attributes of households (preferences and income) that make some households more likely to migrate to the suburbs than others. This paper shows that there exists another fundamental reason for suburbanization. Differences in the local policies of central cities and suburbs can cause suburbanization and the decline of central cities. Local policies differ because majorities differ, specifically, because the percentage of renters is much higher in central cities than in suburbs.

To analyze the effect of different homeownership rates, we develop a dynamic political economy model where the central city corresponds to a region with a renter majority and suburbs correspond to regions with an owner majority. Local policies in the central city and the suburbs differ because renters do not take the effect of local policies on house prices into account. Hence renter dominated central cities have higher debt, higher taxes, and a lower quality of public services than owner dominated suburbs. The combination of high taxes and inefficient public good provision makes living in central cities unattractive compared to living in the suburbs. Therefore, rents and house prices in central cities are low relative to construction costs and the price of land (see Gyourko and Saiz 2003). Hence, few houses are built in the central city while large numbers are built in the suburbs. As houses depreciate, households migrate to the suburbs. These results suggest a new interpretation of suburbanization. Migration to the suburbs is not a 'flight' but the consequence of the depreciation of houses and of house prices that are affected by local policies. While 'flight from blight' theories argue that different incomes and preferences cause suburbanization, the paper shows that the underlying reason for suburbanization is independent of whether households have different incomes, preferences, etc. We show in an extension of the model that different incomes, preferences, etc. do not cause suburbanization but determine only which households migrate to the suburbs.

The model highlights the importance of the durability of houses for local policies. Since houses are durable, the downward adjustment rate of the housing stock is essentially limited by the depreciation rate of houses. If house prices are below construction costs, no new houses are built and the population is determined by the depreciation of the housing stock. Only if house prices are equal or above construction costs, houses are built, and the population growth determines how fast the housing stock grows. The durability of houses is the reason why the direction of causality switches and why the housing supply is inelastic if house prices are below construction costs. These consequences of the durability of houses are important for the local policies. If the policy of a region is inefficient or if its debt is high, the utility from living in this region is low relative to the utility from living in other regions. Unless rents and house prices are lower, all households migrate to a region with a more efficient policy. Since houses are durable, house prices can drop below construction costs, i.e., below house prices in other regions where the population grows. Hence, if policies are inefficient, house prices and rents adjust while the population adjusts only over time as houses depreciate. The paper shows that the durability of houses has two effects:

1) it provides incentives for owners to vote for the efficient policy

2) it makes inefficient policies and a high per-capita debt sustainable.

The model generates clear policy implications. There are two ways to avoid the inefficient provision of public goods. The first is to increase homeownership rates and thereby to change the composition of the electorate. In contrast to renters, owners vote for the efficient provision of public goods. Therefore, programs to increase homeownership rates should not be concentrated on suburbs where the overwhelming majority owns a house but instead on renter dominated central cities and, more general, on jurisdictions with a large proportion of renters. The second is a rule that ties changes in per-capita debt to changes in public good provision. Since the paper does not attempt to analyze the benefits and costs of sprawl, policy implications refer to the inefficient provision of public goods but not to the stop or reversal of suburbanization itself.

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7.1. Appendix

Let j, k denote owner regions and let r denote the renter region. A generic owner region is denoted by o. Let v_o^* be the equilibrium indirect per-period utility from living in an owner region, i.e., $v_o^* = u(x_o^*, y_o^*) - \tau_o^* - r_o^*$.

Proof of Proposition 1

(i) Note that in equilibrium, owner regions implement the same policies and, therefore, $V_{jt+1}(n_t) = V_{kt+1}(n_t) = V_{ot+1}(n_t)$ $\forall t$. Recall that renters do not take house prices into account and that house prices are bounded above by $c + P$. For the proof of part (i), we only assume that $V_{rt+1}(n_t) \leq V_{ot+1}(n_t)$ which is equivalent to the assumption that equilibrium house prices in the renter region are not higher than in the owner regions. We show in part (ii) that, in equilibrium, $V_{rt+1}(n_t) < V_{ot+1}(n_t)$ $\forall t$.

Households vote on the policy x, y, τ. Using the budget constraint eqn.(2) we can write the policy decision as choosing x, y, D. Since x does not affect future utilities and migration, we concentrate on deviations from the equilibrium strategies that affect D and y and show later that x_o^* is optimal.

1) Consider deviations of owner region j in period t such that $V_{jt+1}(n_t) = V_{kt+1}(n_t)$ still holds. Suppose region j provides $y_o^* + dy$ in t where dy is such that $\rho_y(y_o^* + dy) \leq y_o^*$ and adjusts τ_{jt} such that $V_{jt+1}(n_t) = V_{kt+1}(n_t)$ still holds. Since $V_{jt+1}(n_t) = V_{kt+1}(n_t)$ implies that $D_{jt}(1+i) - \rho_y y_{jt} = 0$ still holds, we have $d\tau = \left(1 - \rho_y \delta\right) dy$ and $dD = \rho_y \delta dy$. Since $D_{jt}(1+i) - \rho_y y_{jt} = 0$ still holds and since $\rho_y y_{jt} \leq y_o^*$, optimal policies in $t+1$ and migration between t and $t+1$ are not affected by the deviation and V_{t+1}^* does not change. Since $V_{rt+1}(n_t) \leq V_{ot+1}(n_t)$ we have $n_{jt+1} \geq n_{jt}$ and, therefore, $p_{jt+1} = c + P = p_o^*$, i.e., p_{jt+1} is not affected by the deviation. Since $u'_y(x_o^*, y_o^*) = 1 - \delta\rho_y$ and $u''_{yy} < 0$, the utility gain from additional public goods is smaller than the loss from higher taxes (for $dy < 0$, the utility loss from less public goods is larger than the gain from lower taxes). Hence the deviation reduces $u(x_{jt}, y_{jt}) - \tau_{jt} + \rho\delta p_{jt+1} + \delta V_{t+1}^*$, i.e., reduces the payoff of owners in region j. If dy is so large that $\rho_y y_{jt} > y_o^*$, then $V_{jt+1}(n_t) = V_{kt+1}(n_t)$ implies that there exists $\triangle > 0$ such that $D_{jt}(1+i) - \rho_y y_{jt} = -\triangle$. Hence $d\tau = (1 - \delta\rho_y)dy + \delta\triangle$. From $u'_y(x_o^*, y_o^*) = 1 - \delta\rho_y$, $u''_{yy} < 0$, and $dy > 0$ follows that $u(x_{jt}, y_{jt}) - \tau_{jt}$ decreases by more that $\delta\triangle$. Since households migrate to j, we have $p_{jt+1} = c + P = p_o^*$. Then V_{t+1}^* increases by at most $\frac{\triangle n_{jt}}{n_{jt+1}}$. Since $n_{jt+1} > n_{jt}$, the deviation reduces the payoff of owners in j.

2) Consider deviations of owner region j in period t such that $V_{jt+1}(n_t) > V_{kt+1}(n_t)$. Note that $V_{jt+1}(n_t) > V_{kt+1}(n_t)$ implies that $D_{jt}(1+i) - \rho_y y_{jt} < 0$ and that $n_{jt+1} > n_{jt}$. Hence houses are build in $t+1$ and $p_{jt+1} = c+P = p_o^*$. A deviation from the equilibrium policy via an increase of τ by $d\tau$ reduces D_{jt} by $d\tau$. Hence V_{t+1}^* increases by $(1+i)d\tau\frac{n_{jt}}{n_{jt+1}}$. Since $\delta(1+i) = 1$ and since $V_{jt+1}(n_t) > V_{kt+1}(n_t)$ implies that $n_{jt+1} > n_{jt}$, region j does not want to deviate and reduce the debt such that $V_{jt+1}(n_t) > V_{kt+1}(n_t)$. The same argument shows that region j does not want to deviate and increase both τ_{jt} and y_{jt} such that $V_{jt+1}(n_t) > V_{kt+1}(n_t)$. From this argument follows immediately that it cannot be part of an equilibrium that $V_{jt+1}(n_t) = V_{kt+1}(n_t)$ and $D_{ot}(1+i) - \rho_y y_{ot} < 0$ since both owner regions would have an incentive to decrease taxes in t and increase the debt in t.

3) Above, we considered unilateral deviations of region j in period t such that $V_{jt+1}(n_t) \geq V_{kt+1}(n_t)$. For such deviations of j, neither the other owner region nor the renter region have an incentive to deviate from the equilibrium policies. Now consider deviations of j such that $V_{jt+1}(n_t) < V_{kt+1}(n_t)$. (Similar to the argument above, it is straightforward to show that j cannot gain if it provides an inefficient level of y. Hence we consider only deviations with $\tau_{jt} < \tau_o^*$.) We show first that owners in j are indifferent towards a unilateral deviation with $\tau_{jt} < \tau_o^*$. Then we show that for $\tau_{jt} < \tau_o^*$, owners in k prefer to vote for some τ_{kt} with $\tau_{jt} < \tau_{kt} < \tau_o^*$. Finally, a Bertrand-style argument establishes that $V_{jt+1}(n_t) < V_{kt+1}(n_t)$ cannot be part of an equilibrium.

Consider a unilateral deviation with $\tau_{jt} = \tau_o^* - d\tau$ with $d\tau > 0$ and, therefore $D_{jt}(1+i) - \rho_y y_{jt} > 0$ and $V_{jt+1}(n_t) < V_{kt+1}(n_t)$. Then $n_{jt+1} < n_{jt}$. Since it cannot be part of an equilibrium that the debt increases indefinitely, either in some period taxes are raised above τ_o^* or less public goods are provided. Hence, in that period rents are below r_o^*. Since house prices are equal to the discounted sum of rents plus the discounted price of land, house prices in $t+1$ have to be smaller than $c+P$. Hence no new houses are build in region j in $t+1$ and $n_{jt+1} = \rho n_{jt}$. Suppose region j repays the additional debt in $t+1$. Then τ_{jt+1} has to increase by $(1+i)d\tau\frac{n_{jt}}{n_{jt+1}}$. Note that V_{t+1}^* (and similar V_{t+2}^* and so on) is not affected by a unilateral deviation with $\tau_{jt} < \tau_o^*$. Consider an owner household in j. With probability $1-\rho$ his house depreciates and the household receives V_{t+1}^*. If the house does not depreciate, assume wlog. that the household stays in j (the assumption is wlog. because, in equilibrium, households are indifferent towards the region they live in). The discounted utility of an owner in region j in t can be written as $u(x_{jt}, y_{jt}) - \tau_{jt} + (1-\rho)\delta V^*_{t+1} + \rho\delta(u(x_{jt+1}, y_{jt+1}) - \tau_{jt+1} + V^*_{t+2})$. Since τ_{jt+1} increases by $(1+i)d\tau\frac{n_{jt}}{n_{jt+1}}$ with $n_{jt+1} = \rho n_{jt}$ owners are indifferent towards a unilateral deviation with $\tau_{jt} < \tau^*_o$. Of course, the same argument implies that owners are indifferent towards deviating and repaying the additional debt in $t+2$, and so on.

Now we show that for $\tau_{jt} < \tau^*_o$, owners in k prefer to vote for some τ_{kt} with $\tau_{jt} < \tau_{kt} < \tau^*_o$. Consider $\tau_{jt} = \tau^*_o - \triangle$ with $\triangle > 0$. For any $\triangle > 0$ exists ϵ with $\triangle > \epsilon > 0$ such that region k can implement $\tau_{kt} = \tau^*_o - \epsilon$ and $V_{jt+1}(n_t) < V_{kt+1}(n_t)$ and $V_{rt+1}(n_t) < V_{kt+1}(n_t)$ still hold. Then households migrate from region j to region k and $n_{jt+1} = \rho n_{jt}$ and $n_{kt+1} > n_{kt}$ and, therefore, $p_{kt+1} = p^*_o$ since houses are build in k. Suppose that the additional debt is paid back in $t+1$. Then $\tau_{kt+1} = \tau^*_o + \frac{(1+i)\epsilon n_{kt}}{n_{kt+1}}$. From $n_{kt+1} > n_{kt}$ follows that $\epsilon - \delta\frac{(1+i)\epsilon n_{kt}}{n_{kt+1}} > 0$ and, therefore, it is indeed optimal for k to reduce τ_{kt}. Since $\epsilon - \delta\frac{(1+i)\epsilon n_{kt}}{n_{kt+1}}$ is increasing in ϵ, the best response to $\tau_{jt} < \tau^*_o$ is not well-defined because of an open set problem.

We have shown above that owners in j are indifferent towards a unilateral deviation with $\tau_{jt} < \tau^*_o$ since V^*_{t+1} does not change. However, if region k reduces τ_{kt} with $\tau_{jt} < \tau_{kt} < \tau^*_o$, then V^*_{t+1} decreases by $\frac{(1+i)\epsilon n_{kt}}{n_{kt+1}}$. Applying the same argument as above, owners in j would have been better off if they implemented some tax $\widetilde{\tau}_{jt}$ with $\tau_{kt} < \widetilde{\tau}_{jt} < \tau^*_o$.

From this argument follows immediately that it cannot be part of an equilibrium that $V_{jt+1}(n_t) = V_{kt+1}(n_t)$ and $D_{ot}(1+i) - \rho_y y_{ot} > 0$ since both owner regions would have an incentive to increase taxes in t and to decrease the debt in t.

Hence in equilibrium $V_{jt+1}(n_t) = V_{kt+1}(n_t)$ and $D^*_o(1+i) - \rho_y y^*_o = 0$. Since $D^*_o(1+i) - \rho_y y^*_o = 0$, migration reduces the per-capita debt and the level of durables in an owner region by the same amount and, therefore, $V^*_{t+1} = V_{ot+1}(n_t)\ \forall t$. Hence V^*_{t+1} and equilibrium policies of owner regions depend neither on the mass of households that migrate to the owner regions nor on the relative mass of households in the owner regions. Note that $D^*_o(1+i) - \rho_y y^*_o = 0$ implies that $\tau^*_o > 0$. Hence $u'_x(x^*_o, y^*_o) = 1$. In part 1 we have shown that, in equilibrium, owner regions provide y such that $u'_y = 1 - \rho_y\delta$. Hence $y^*_o = y^e$ and $x^*_o = x^e$. Then D^*_o and τ^*_o follow immediately. In equilibrium, owner regions implement the same policy and house prices and rents across owner regions are the same and constant over time. Hence $p_o^* = c + \frac{l}{1-\delta}$ and $r_o^* = (1 - \rho\delta)c + l$.

We show in the proof of (ii) that the population of the renter region decreases. Since owner regions implement the same policy, it follows immediately from the migration rule that the population in the owner regions increases.

(ii) We show first that it cannot be part of an equilibrium that $V_{rt+1}(n_t) \geq V_{ot+1}(n_t)$. Recall that renters vote for the policy that maximizes $u(x_{jt}, y_{jt}) - \tau_{jt} + \delta V_{t+1}^*$ while owners vote to maximize $u(x_{jt}, y_{jt}) - \tau_{jt} + \delta V_{t+1}^* + \rho\delta p_{jt+1}$. Hence it cannot be part of the equilibrium that house prices are higher in the renter region. Suppose that there exists some t such that $V_{rt+1}(n_t) > V_{ot+1}(n_t)$. Since equilibrium house prices cannot be higher in the renter region and since some houses have to be built, we have $p_{ot+1} = c+P$. Hence $n_{ot+1} \geq \rho n_{ot}$. Since $\rho_y < \rho$, the condition that $y_{ot} \geq \rho_y y_{ot-1} \frac{n_{ot-1}}{n_{ot}}$ does not bind. Hence in equilibrium, the policies in owner regions are indeed independent from the policy of the renter region (as assumed in the proof of part (i)). Therefore, $V_{ot+1}(n_{t+1}) = V_{ot+1}(n_t) = V_{t+1}^*$. As shown in the proof of part (i), in equilibrium, V_{t+1}^* does not change if more households migrate to the owner region. Renters vote to maximize $u(x_{rt}, y_{rt}) - \tau_{rt} + \delta V_{t+1}^*$. Hence it cannot be part of an equilibrium that $V_{rt+1}(n_t) > V_{ot+1}(n_t)$ because renters in the renter region prefer to decrease τ_{rt} and increase D_{rt} because this does not affect V_{t+1}^*.

Hence, in equilibrium, $V_{rt+1}(n_t) < V_{ot+1}(n_t)$ and V_{t+1}^* is independent of the mass of households that migrate to the owner regions. Hence, in equilibrium, the policy in the renter region maximizes $u(x_{rt}, y_{rt}) - \tau_{rt}$, subject to $\tau_{rt} \geq 0$, $y_{rt} \geq \rho_y y_{rt-1} \frac{n_{rt-1}}{n_{rt}}$, subject to eqn.(2) and subject to the constraint that banks approve the debt contract. Hence $D_{rt}^* = D_{rt}^{\max}\ \forall t$. Then x_{r1}^*, y_{r1}^*, and τ_{r1}^* follow immediately.

Next, we show that $p_{rt}^* < c+P$. Suppose that $p_{rt} = c+P \forall t > 1$. Then $\sum(\delta\rho)^s r_{rt+s} = \sum(\delta\rho)^s r_o^* \forall t > 1$. Since migration is costless, in equilibrium, indirect per period utilities are equal across regions. Hence $\sum(\delta\rho)^s r_{rt+s} = \sum(\delta\rho)^s r_o^* \forall t > 1$ implies that $\sum(\delta\rho)^s[u(x_{rt+s}, y_{rt+s}) - \tau_{rt+s}] = \sum(\delta\rho)^s[u(x^e, y^e) - \tau_o^*]\forall t > 1$ and, therefore, that

$$u(x_{rt}, y_{rt}) - \tau_{rt} = u(x^e, y^e) - \tau_o^* \forall t > 1 \tag{A1}$$

Recall that $\tau_{rt} = x_{rt} + y_{rt} + \frac{n_{rt-1}}{n_{rt}}(D_{rt-1}(1+i) - \rho_y y_{rt-1}) - D_{rt}$. Since $u(x,y) - x - (1-\rho_y\delta)y \leq u(x^e,y^e) - x^e - (1-\rho_y\delta)y^e \forall x,y$ and $\tau_o^* = x^e + (1-\rho_y\delta)y^e$ eqn.(A1) implies that $-\frac{n_{rt-1}}{n_{rt}}(D_{rt-1}(1+i) - \rho_y y_{rt-1}) + D_{rt} \geq \rho_y \delta y_{rt}$. Since $V_{rt+1}(n_t) < V_{ot+1}(n_t)$, in equilibrium, $\frac{n_{rt}}{n_{rt+1}} > 1$. From induction follows that eqn.(A1) implies that

$$D_{rt}(1+i) - \rho_y y_{rt} \geq (1+i)^{t-1}(D_{r1}(1+i) - \rho_y y_{r1}) \tag{A2}$$

Hence if $D_{r1}^{\max}(1+i) - \rho_y y_{r1}^* > 0$, then $p_{rt} = c + P \forall t > 1$ cannot be part of an equilibrium because eqn.(A2) would imply that $\lim_{t\to\infty} D_{rt} = \infty$. In $t = 1$, renters vote for the policy that maximizes $u(x_{r1}, y_{r1}) - \tau_{r1}$ subject to $\tau_{r1} \geq 0$, to eqn.(2), and to $D_{r1} \leq D_{r1}^{\max}$. Hence if $y_{r1}^* > y^s$ it has to be true that $D_{r1}^{\max}(1+i) - \rho_y y_{r1}^* > 0$ and we are done. Note that $y_{r1}^* < y^s$ cannot be part of the equilibrium. Hence consider $y_{r1}^* = y^s$. Note that $p_{rt} = c + P \forall t > 1$ would imply that $n_{rt} \geq \rho n_{rt-1} \forall t > 1$. Since $D_{rt}^* = D_{rt}^{\max}$, it is sufficient to show that there exists $\epsilon > 0$ such that banks make non-negative profits if $D_{r1} = \delta \rho_y y^s + \epsilon$. Consider $D_{rt}^{\max} = \delta \rho_y y^s$ $\forall t$. Then $y_{rt} = y^s$ and $x_{rt} = x^s$ for all t. Recall that $r_o^* = l + c(1-\rho\delta)$. From Assumption 2 follows that there exists $r_{rt} > l$ such that for $n_{rt} \in [\rho n_{rt-1}, n_{rt-1}]$ the indirect per-period utilities are equal across regions. Hence there exists $\epsilon > 0$ such that $D_{rt}^{\max} \geq \delta \rho_y y^s + \epsilon$ for all t. Hence $p_{rt} = c + P \forall t > 1$ cannot be part of the equilibrium.

It remains to show that it cannot be part of the equilibrium that there exists $\widehat{t} > 0$ such that $p_{r\widehat{t}} = c + P$. Suppose the contrary, i.e., suppose that in equilibrium, there exist $\widehat{t} > 1$ and $\Delta > 0$ such that $p_{r\widehat{t}} = c + P$ and $p_{r\widehat{t}+1} = c + P - \frac{\triangle}{\rho\delta}$. Then $u(x_{r\widehat{t}}, y_{r\widehat{t}}) - \tau_{r\widehat{t}} = u(x^e, y^e) - \tau_o^* + \triangle$ and $\sum_{s=1}^{\infty}(\delta\rho)^s[u(x_{r\widehat{t}+s}, y_{r\widehat{t}+s}) - \tau_{r\widehat{t}+s}] = \sum(\delta\rho)^s[u(x^e,y^e) - \tau_o^*] - \frac{\triangle}{\rho\delta}$. Note that $p_{r\widehat{t}} = c + P$ implies that $n_{r\widehat{t}} = h_{r\widehat{t}}$ and, therefore, $p_{r\widehat{t}+1} < c + P$ implies that $n_{r\widehat{t}+1} \leq \rho n_{r\widehat{t}}$. Consider a rearrangement of taxes and rents in the renter region such that indirect per-period utilities do not change, the population does not change, and the debt in the last period under consideration does not increase. Specifically, consider an increase of $\tau_{r\widehat{t}}$ by $\triangle$ and a reduction of $r_{r\widehat{t}}$ by $\triangle$ and a reduction of $\tau_{r\widehat{t}+1}$ by $\frac{\triangle}{\rho\delta}$ and an increase of $r_{r\widehat{t}+1}$ by $\frac{\triangle}{\rho\delta}$. Then $p_{r\widehat{t}} = p_{r\widehat{t}+1} = c + P$ and $D_{r\widehat{t}+1}$ does not increase compared to the situation before taxes and rents were changed. In the same way, one can change taxes and rents such that $p_{rt} = c + P \forall \widehat{t} \leq t \leq \widetilde{t}$ such that $D_{r\widetilde{t}}$ does not increase compared to the situation before taxes and rents were changed. Consider the limit as $\widetilde{t}$ goes to infinity. Recall that we showed above that $p_{rt} = c + P \forall t \geq \widehat{t}$ would imply that $\lim_{t\to\infty} D_{rt} = \infty$ and that $D_{r\widetilde{t}}$ is not higher after the rearrangement. Hence $p_{r\widehat{t}} = c + P$ for some $\widehat{t} > 1$ implies that $\lim_{t\to\infty} D_{rt} = \infty$ which cannot be part of an equilibrium. Hence $p^*_{rt} < c + P\forall t$. Hence no houses are built in the renter region and, therefore, $n^*_{rt} \leq \rho h_{rt-1} \forall t > 1$. Hence $n^*_{rt} \leq \rho^{t-1} n_{r1} \forall t > 1$.

We show next that $D_{rt} = D^{\max}_{rt}$ and $n_{rt+1} \leq \rho n_{rt}$ imply that $r_{rt+1} = l$. In equilibrium, the discounted 'profit' from owning a house has to be bigger or equal than the sum of discounted land rents, i.e., $\sum_{s=0}^{\infty}(\rho\delta)^s r_{rt+s} + \sum_{s=0}^{\infty} \delta(1-\rho)(\rho\delta)^s \frac{l}{1-\delta} \geq \frac{l}{1-\delta}$ $\forall t > 1$. Rewrite this as $\sum_{s=0}^{\infty}(\rho\delta)^s r_{rt+s} \geq \frac{l}{1-\rho\delta}$. Suppose that there exists t such that $\sum_{s=0}^{\infty}(\rho\delta)^s r_{rt+s} > \frac{l}{1-\rho\delta}$. Then there exists $\widehat{t}$ and $\triangle > 0$ such that $r_{r\widehat{t}} = l + \triangle$. Suppose that banks agree to increase $D_{r\widehat{t}-1}$ by $\frac{\triangle n_{r\widehat{t}}}{(1+i)n_{r\widehat{t}-1}}$. For simplicity, assume that $y_{r\widehat{t}-1}$ is not affected by the increase of $D_{r\widehat{t}-1}$ (which is true in equilibrium for Δ sufficiently small). Except for $\tau_{r\widehat{t}}$, the policy in $\widehat{t}$ does not change. Hence $D^{\max}_{r\widehat{t}}$ does not change and $\tau_{r\widehat{t}}$ has to increase by $\triangle$. Of course, households anticipate the increase of $\tau_{r\widehat{t}}$ and, therefore, $r_{r\widehat{t}}$ decreases by $\triangle$ and indirect per-period utilities in $\widehat{t}$ and, therefore, the population allocation in $\widehat{t}$ are not affected. Hence $\sum_{s=0}^{\infty}(\rho\delta)^s r_{rt+s} > \frac{l}{1-\rho\delta}$ implies that banks can increase the debt and still make non-negative profits. (The argument is similar if $y_{r\widehat{t}-1}$ changes). Since $D^*_{rt} = D^{\max}_{rt}$ $\forall t$, in equilibrium, $\sum_{s=0}^{\infty}(\rho\delta)^s r_{rt+s} = \frac{l}{1-\rho\delta}$ for all $t > 1$. Hence, $r^*_{rt} = l$ and $p^*_{rt} = \frac{l}{1-\delta}$ $\forall t > 1$.

Since migration is costless, at the equilibrium population allocation, indirect per-period utilities are equal across regions. Since $r^*_{rt} = l$ $\forall t > 1$ and $r^*_{ot} = l + (1-\rho\delta)c$ $\forall t > 1$, it follows from Assumption 2 that $\tau_{rt} > 0 \forall t > 1$. As shown above, renters vote to maximize $u(x_{rt}, y_{rt}) - \tau_{rt}$ subject to $\tau_{rt} \geq 0$, to eqn.(2), to $D_{rt} \leq D^{\max}_{rt}$ and to $y_{rt} \geq \rho_y y_{rt-1} \frac{n_{rt-1}}{n_{rt}}$. Then x^*_{rt}, y^*_{rt}, and τ^*_{rt} follow immediately.

Let $\overline{n}_{rt} = \min[n_{rt-1}, \rho h_{rt-1}]$. Recall that migration between $t-1$ and t starts at n_{rt-1}. Then for all $n_{rt} \leq n_{rt-1}$ in equilibrium $v_{rt}(n_{rt}) \leq v^*_o$ because otherwise $D_{rt-1} < D^{\max}_{rt-1}$. Hence the migration rule implies that $n^*_{rt} \leq n_{rt-1}$. Since $r^*_{rt} = l$ it follows that $n^*_{rt} \leq \overline{n}_{rt}$. To show that $n^*_{rt} = \rho^{t-1} n_{r1}$ we show first that v_{rt} is increasing in n_{rt} for $n_{rt} \leq \overline{n}_{rt}$.

Case I: $y^s < \frac{n_{rt-1}}{n_{rt}} \rho_y y_{rt-1}$.

Since $\tau^*_{rt} > 0$ we have $y_{rt} = \frac{n_{rt-1}}{n_{rt}} \rho_y y_{rt-1}$. Hence, the total amount of the durable public good in the renter region is independent of n_{rt}. Since v_{rt+1} depends on the total amount of debt and durables in t,

$D_{rt}^{\max}$ depends on n_{rt}. Since $D_{rt}^{*} = D_{rt}^{\max}$ we can write the total equilibrium debt in t as $n_{rt} D_{rt}^{\max}(n_{rt})$. In equilibrium, $n_{rt} D_{rt}^{\max}(n_{rt})$ is non-decreasing in n_{rt} for $n_{rt} \leq \overline{n}_{rt}$. To see why, suppose the opposite. Then there exists $\widetilde{n}_{rt} < \widehat{n}_{rt}$ such that $\widetilde{n}_{rt} D_{rt}^{\max}(\widetilde{n}_{rt}) > \widehat{n}_{rt} D_{rt}^{\max}(\widehat{n}_{rt})$. Let $\widetilde{v}_{rt+1}$ and $\widehat{v}_{rt+1}$ be the indirect per-period utilities if the population in t is $\widetilde{n}_{rt}$ and $\widehat{n}_{rt}$. Then $\widehat{v}_{rt+1} > \widetilde{v}_{rt+1}$ for all $n_{rt+1} \leq \rho h_{rt}$. This cannot be part of an equilibrium because either $D_{rt}(\widehat{n}_{rt}) < D_{rt}^{\max}(\widehat{n}_{rt})$ or the renter region defaults in $t+1$ if $n_{rt} = \widetilde{n}_{rt}$. Hence $n_{rt} D_{rt}^{\max}(n_{rt})$ is non-decreasing in n_{rt}.

Let B_{rt} be the total transfer from the renter region to banks in t. Since by assumption $y^s < \frac{n_{rt-1}}{n_{rt}} \rho_y y_{rt-1}$ we have $y_{rt} = \frac{n_{rt-1}}{n_{rt}} \rho_y y_{rt-1}$ and, therefore, $B_{rt} = n_{rt}(\tau_{rt} - x_{rt})$. Note that B_{rt}, τ_{rt}, and x_{rt} are functions of n_{rt}. Since the total debt is non-decreasing in n_{rt}, we know that B_{rt} is non-increasing in n_{rt}. Suppose that B_{rt} is constant. Recall that $r_{rt}^{*} = l$ and that $u_x' = 1$ at x_{rt}^{*}. Then $\frac{\partial v_{rt}}{\partial n_{rt}} = -u_y' \rho_y y_{rt-1} \frac{n_{rt-1}}{{n_{rt}}^2} + \frac{B_{rt}}{{n_{rt}}^2}$ for $n_{rt} \leq \rho h_{rt-1}$. Since $r_{rt}^{*} = l$ and $v_{rt}(n_{rt}) \leq v_o^{*}$ for all $n_{rt} \leq n_{rt-1}$ it follows from Assumption 2 that $u(x_{rt}, y_{rt}) - \tau_{rt} < u(x^s, y^s) - x^s - y^s$. Hence $\tau_{rt} - x_{rt} > u_y' y_{rt}$. Hence if B_{rt} is constant, v_{rt} is increasing in n_{rt} for all $n_{rt} \leq \rho h_{rt-1}$. Obviously, v_{rt} is also increasing in n_{rt} if B_{rt} is decreasing in n_{rt}.

Case II: $y^s \geq \frac{n_{rt-1}}{n_{rt}} \rho_y y_{rt-1}$.

Hence $y_{rt} = y^s$ and the total amount of the durable public good is increasing in n_{rt}. Let $Q(n_{rt}) = n_{rt} D_{rt}^{\max}(n_{rt})$. The same argument as in Case I shows that $Q(n_{rt})$ has to be non-decreasing in n_{rt}. Then $\frac{\partial D_{rt}^{\max}}{\partial n_{rt}} \geq -\frac{Q(n_{rt})}{(n_{rt})^2}$. Since $v_{rt}(n_{rt}) = u(x^s, y^s) - x^s - y^s - \frac{n_{rt-1}}{n_{rt}} \left[D_{rt-1}^{\max} \cdot (1+i) - \rho_y y_{rt-1}\right] + D_{rt}^{\max}(n_{rt}) - l$ we have $\frac{\partial v_{rt}}{\partial n_{rt}} \geq \frac{n_{rt-1}}{(n_{rt})^2} \left[D_{rt-1}^{\max} \cdot (1+i) - \rho_y y_{rt-1}\right] - \frac{Q(n_{rt})}{(n_{rt})^2}$. From $v_{rt}(n_{rt}) \leq v_o^{*}$ for all $n_{rt} \leq n_{rt-1}$ it follows that Assumption 2 implies that for all $n_{rt} \leq \overline{n}_{rt}$ we have $n_{rt-1} \left[D_{rt-1}^{\max} \cdot (1+i) - \rho_y y_{rt-1}\right] > Q(\overline{n}_{rt})$. Hence $\frac{\partial v_{rt}}{\partial n_{rt}} > 0$ for all $n_{rt} \leq \overline{n}_{rt}$.

We have shown that v_{rt} is increasing in n_{rt} for all $n_{rt} \leq \overline{n}_{rt}$. Recall that $n_{r1} = h_{r1}$. Since v_{rt} is increasing and since banks accept all debt contracts on which they make non-negative profits and the renter region takes out the maximal debt, $n_{rt}^{*} = \rho h_{rt-1}$ for all $t > 1$ and, therefore, $n_{rt}^{*} = \rho^{t-1} n_{r1}$.

Recall that $\rho_y < \rho$. From $n_{rt}^{*} = \rho h_{rt-1}$ and $\tau_{rt}^{*} > 0$ for all $t > 1$ it follows immediately that there exists $T < \infty$ such that $y_{rt}^{*} = y^s$ and $x_{rt}^{*} = x^s$ for all $t \geq T$. Since the public good provision is constant for $t \geq T$ and since $r_{rt}^{*} = l$ for $t > 1$, debt, and therefore, taxes are constant for $t \geq T$.

(iii) Banks are perfectly competitive. Standard Bertrand-style arguments establish that banks accept all debt contracts which yield non-negative profits. Banks decide whether to accept debt contracts before policies are realized. Since y_{jt} and D_{jt} affect $V_{jt+1}(n_t)$, they affect migration and policies in $t+1$. Therefore, $D^{\max}$ is a function of the expected policies and banks compute $D^{\max}$ under the assumption that regions implement the equilibrium policies. Since there are no stochastic elements, there is no uncertainty about equilibrium policies and migration. Hence, in equilibrium, regions do not default and banks charge the risk-free interest rate i.

As shown in the proof of part (i), owner regions take out debt D_o^* although they could repay a larger debt. Hence $D_o^* < D_{ot}^{\max}$ $\forall t$ and the constraint that banks have to accept debt contracts does not bind for owner regions. It remains to show that there exists a unique $D_{rt}^{\max}$ such that banks accept debt contracts of the renter region if and only if $D_{rt} \leq D_{rt}^{\max}$.

In the first period, the renter region chooses $x_{r1}, y_{r1}, \tau_{r1}$ to maximize $u(x_{r1}, y_{r1}) - \tau_{r1}$ s.t. $D_{r1} \leq D_{r1}^{\max}$ and eqn.(2). Hence $D_{r1}^{\max}$ determines a unique y_{r1}^*. As shown above, $\tau_{rt}^* > 0 \forall t > 1$ and $n_{rt}^* = \rho^{t-1} n_{r1}$. Hence $y_{rt}^* = \max\left\{y^s, \left(\frac{\rho_y}{\rho}\right)^{t-1} y_{r1}^*\right\}$. Therefore, $D_{r1}^{\max}$ determines a unique x_{rt}^* and y_{rt}^* $\forall t$. Given $D_{r1}^{\max}$, let T be the first period in which $y_{rt}^* = y^s$, i.e., T is the unique integer for which $\left(\frac{\rho_y}{\rho}\right)^{T-2} y_{r1}^* > y^s \geq \left(\frac{\rho_y}{\rho}\right)^{T-1} y_{r1}^*$. For all $t \geq T$, $y_{rt}^* = y^s$ and $x_{rt}^* = x^s$. As shown above, $r_{rt}^* = l$. Let v_o^* denote the per-period utility from living in an owner region. Since in equilibrium indirect per-period utilities are equal across regions, we have $u(x^s, y^s) - \tau_{rt}^* - l = v_o^*$ for all $t \geq T$. Since $D_{rt}^* = D_{rt}^{\max}$, $y_{rt}^* = y^s$, and $x_{rt}^* = x^s$ for $t \geq T$ we have $\tau_{rt}^* = x^s + y^s\left(1 - \frac{\rho_y}{\rho}\right) + D_{rt-1}^{\max}(1+i)\frac{1}{\rho} - D_{rt}^{\max}$ for $t \geq T$. Since it cannot be part of the equilibrium that the debt explodes, $D_{rt}^{\max}$ is constant for all $t \geq T$. Define the long-run per-capita debt $D_{r\infty}^{\max}$ as the unique solution to

$$u(x^s, y^s) - x^s - \frac{(1+i-\rho)}{\rho} D_{r\infty}^{\max} - \left(1 - \frac{\rho_y}{\rho}\right) y^s - l = v_o^*$$

Then $D_{rt}^{\max} = D_{r\infty}^{\max}$ for all $t \geq T$. If $x^s + y^s \geq D_{r\infty}^{\max}$, we have $T = 1$ and obviously $D_{rt}^{\max}$ exists and $D_{rt}^{\max} = D_{r\infty}^{\max}$ $\forall t$.

Now consider the case where $x^s + y^s < D_{r\infty}^{\max}$. In this case, $T > 1$. Given y_{rt-1} and D_{rt-1}, define $\overline{D}_{rt}$ as the minimal debt in t such that the renter region does not default in t if regions implement the equilibrium policies. Hence for $t > 1$, $\overline{D}_{rt}$ is defined by

$$u(x_{rt}^*, y_{rt}^*) - x_{rt}^* - \frac{D_{rt-1}(1+i)}{\rho} + \overline{D}_{rt} - y_{rt}^* + \frac{\rho_y}{\rho} y_{rt-1} - l = v_o^* \quad \forall t > 1 \tag{A3}$$

where $y_{rt}^* = \max\left\{y^s, \left(\frac{\rho_y}{\rho}\right)^{t-1} y_{r1}^*\right\}$ and x_{rt}^* is defined by $u_x' = 1$. Applying eqn.(A3) recursively where D_{rt-1} is set equal to $\overline{D}_{rt-1}$ when computing $\overline{D}_{rt}$ generates for every D_{r1} a sequence $\left(\overline{D}_{rt}\right)_{t=2}^{\infty}$.

Banks accept all credit contracts with non-negative profits and the renter region takes out as much debt as possible. Hence $D_{r1}^{\max}$ is the highest D_{r1} such that there exists T with $\overline{D}_{rT} = D_{r\infty}^{\max}$. From $\frac{\partial^2 u}{\partial^2 x} < \frac{\partial^2 u}{\partial x \partial y}$ follows that y_{r1}^* is increasing in D_{r1} and, therefore, T is weakly increasing in D_{r1}. Hence there exists a sequence of intervals $(a_s, b_s]$ with $s \in \mathbb{N}$, $a_1 = 0$, and $b_s = a_{s+1}$, such that $D_{r1} \in (a_s, b_s]$ implies that $T = s$. Since y_{rt}^* is continuous in D_{r1}, x_{rt}^* is also continuous in D_{r1}. Hence, the term $u(x_{rt}^*, y_{rt}^*) - x_{rt}^* - y_{rt}^*$ in eqn.(A3) is continuous in D_{r1}. Therefore, $\overline{D}_{rt}$ is continuous in D_{r1}.

Write $\overline{D}_{rt}$ as function of D_{r1}. Assumption 2 implies that $\overline{D}_{rt}(0) < 0$ for all $t > 1$. Since u is bounded from above, $\lim_{D_{r1} \to \infty} \overline{D}_{rt}(D_{r1}) = \infty$ for all t. Hence, $0 < D_{r1}^{\max} < \infty$ and, therefore, $T < \infty$. For an arbitrary s, if $\overline{D}_{rs}(a_s) < D_{r\infty}^{\max}$ and $\overline{D}_{rs}(b_s) \geq D_{r\infty}^{\max}$, then by continuity of $\overline{D}_{rt}$ there exists $D_{r1} \in (a_s, b_s]$ such that $\overline{D}_{rs}(D_{r1}) = D_{r\infty}^{\max}$. Recall that $D_{r1} \in (a_s, b_s]$ implies that $T = s$. If $\overline{D}_{rs}(b_s) < D_{r\infty}^{\max}$, then from $b_s = a_{s+1}$ and from eqn.(A3) follows that $\overline{D}_{rs+1}(a_{s+1}) < D_{r\infty}^{\max}$. Hence, $\overline{D}_{rt}(0) < 0$, continuity of $\overline{D}_{rt}$, and the fact that $\lim_{D_{r1} \to \infty} \overline{D}_{rt} = \infty$ imply that there exists at least one s with $D_{r1} \in (a_s, b_s]$ such that $T = s$ and $\overline{D}_{rs}(D_{r1}) = D_{r\infty}^{\max}$. Additionally, continuity of $\overline{D}_{rt}$ guarantees that there exists a largest D_{r1} s.t. there exists s with $D_{r1} \in (a_s, b_s]$, $T = s$, and $\overline{D}_{rs}(D_{r1}) = D_{r\infty}^{\max}$. Hence $D_{r1}^{\max}$ and, therefore, $D_{rt}^{\max}$ are well-defined.

In equilibrium, regions do not default. To see why banks cancel part of the debt if a region is in default, suppose that region j is in default at the end of period $t-1$. If region j is still in default in t, then it will fail to meet its debt repayment obligation in t. If households vote for $\tau_{jt} > 0$, banks optimally seize tax receipts until the debt is repaid. From Definition 1 follows that it cannot be optimal to vote for taxes that are higher than the outstanding debt. Hence banks seize the complete tax revenue. Hence households vote for $\tau_{jt} = 0$ and, therefore, $x_{jt} = 0$ and $y_{jt} = \rho_y \frac{n_{jt-1}}{n_{jt}} y_{jt-1}$. Consider migration between $t-1$ and t. Households either migrate to another region or stay in region j and vote for $\tau_{jt} = 0$. Regardless of n_{jt}, banks receive zero. Of course, the same logic applies if region j is still in default in $t+1$. The only way to ensure that at least part of the debt is repaid is to reduce the debt such that region j is not in default anymore. Once region j is not in default anymore, Definition 1 implies that households vote for policies such that the (reduced) debt is repaid. From Assumption 2 follows that regions can sustain a positive per-capita debt. Hence banks reduce the debt by the minimal amount such that region j is not in default anymore.